**IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION**

CAPELLA PHOTONICS, INC. Plaintiff, v. INFINERA CORPORATION, TELLABS, INC., TELLABS OPERATIONS INC., CORIANT AMERICA INC., and CORIANT (USA) INC., Defendants.	Case No. 2:20-cv-00077-JRG

DECLARATION OF ALEXANDER SERGIENKO

I, Alexander Sergienko, declare and state as follows:

1. My name is Alexander V. Sergienko. Capella Photonics, Inc. has retained me as an expert witness. I have been asked to provide my expert opinions regarding U.S. Patent Nos. RE47,905 and RE47,906 (the "'905" and "'906" patents; collectively the "Asserted Patents").

2. I am being compensated for my work at a rate of $475 per hour. My compensation is not contingent upon, and in no way affects, the substance of my testimony.

QUALIFICATIONS

3. I have a Ph.D. in Quantum Radiophysics from Moscow State University in 1987 and a Master of Science Degree in Physics from Moscow State University in 1981.

4. I am currently a full professor at Boston University where I hold joint appointments in the Photonics Center, the Department of Electrical and Computer Engineering, and the Department of Physics. My expertise and research interests include optics, photonics, quantum physics, laser physics, nonlinear optics, and precise optical measurement in telecommunication and optical engineering.

5. I have experience and familiarity with the technical areas involved in this case. With over 30 years of research experience in the field of optics, I have studied and worked with optical components such as those at issue in this case. For example, during my tenure as a Director of the Quantum Communication and Measurement laboratory at the Boston University Photonics Center, I developed quantum optical technologies for high-resolution evaluation of optical device parameters (*e.g.*, fibers, switches, and amplifiers). With this research I have evaluated the differences in wavelength selective switches produced by commercial vendors. I have thus studied switching technologies such as microelectromechanical ("MEMS") mirrors, liquid crystal ("LC"), combined MEMS+LC, and liquid crystal on silicon ("LCOS").

6. For more than a decade, my focus has been on high-resolution measurement of polarization mode dispersion ("PMD") in modern wavelength selective switches operating in 40 Gb/s and 100 Gb/c telecommunication reconfigurable optical add-drop multiplexer networks. I have worked to develop measurement technologies that are based on the use of quantum properties of light and enable measurement of PMD in discrete telecommunication devices, fibers, and switches with a superior resolution of < 1fs. For details on my research regarding high-resolution measurement of PMD, *see*, *e.g.*, Fraine, D.S. Simon, O. Minaeva, R. Egorov, and A.V. Sergienko, *Precise Evaluation of Polarization Mode Dispersion by Separation of Even- and Odd-Order Effects in Quantum Interferometry*, OPTICS EXPRESS, v. 19, no. 21, 22820 (2011).

7. I have published 132 technical papers in research journals in the area of photonics, physics, and optical technology. Several of these research journals include: Nature Communications; Journal of the Optical Society of America; Physical Review Letters; and Physical Review A. I have presented more than 300 research papers at major international

research conferences. I have contributed 7 book chapters on precise optical measurement and quantum optics. I have also served as the sole editor of a book titled Quantum Communications and Cryptography.

8. I have taught courses in optical measurement, quantum optics, photonics, electrical circuit theory, and analog electronics. I have also been an advisor to graduate students researching various subjects in physics, electrical engineering, and photonics.

9. I am a Fellow of the Optical Society of America (OSA) (<10% of total OSA members) and have been a lead of the Quantum Computing and Communication Technical Group at OSA for several years. I am a member of the American Physical Society and a member of IEEE.

10. From 1990 to 1996, I worked for the University of Maryland and the National Institute of Standards and Technology ("NIST"). While at NIST, I developed several novel optical measurement technologies that outperformed existing conventional approaches both in resolution and in accuracy. In 1996, I joined the Photonics Center and the Department of Electrical and Computer Engineering at Boston University. I have since been a member of the Boston University faculty.

11. My *curriculum vitae*, which contains further details on my education, experience, publications, patents, and other qualifications, is attached hereto as Exhibit A.

INFORMATION CONSIDERED FOR THIS DECLARATION

12. I have been asked to provide a technical review, analysis, insights, and opinions regarding the following references. My opinions are based on over 30 years of education, research, and experience, as well as my study of relevant materials.

13. I have reviewed and am familiar with the '905 and '906 patent specifications, their claims, and their prosecution history. The original (U.S. Patent Nos. RE42,368 and RE42,678; the "'368" and "'678" patents) and reissued ('905 and '906) Asserted Patents all share the same specification. For purposes of discussion, the '678 specification will be used unless otherwise noted.

14. The prosecution history includes a series of recently concluded IPRs. I served as an expert witness in those IPRs for Capella.

15. I understand that the Asserted Patents claim the benefit of U.S. Provisional App. No. 60/277,217 (the "'678 Provisional"), filed on March 19, 2001.

16. I have reviewed and am familiar with at least the following listed references. I may rely upon these materials to respond to any rebuttal to my declaration and opinions. The listed Exhibits are from my declaration filed in IPR2015-00727 for U.S. Patent RE42,678. I filed similar declarations in the other IPRs. Please note that I refer to '678 patent in many paragraphs below for convenience. However, the '368, '678, '905 and '906 patents all share the same specification. Unless otherwise noted, a reference to the '678 patent is also a reference to the '368 three patents. Also, unless otherwise noted, citations are from IPR2015-00727 for U.S. Patent RE42,678.

IPR Exhibit No.	Reference
1001	U.S. Patent No. RE42,368 to Chen et al.
1002	U.S. Patent No. 6,498,872 to Bouevitch et al.
1003	Prosecution History for U.S. Patent No. RE42,368
1004	Joseph E. Ford et al., *Wavelength Add-Drop Switching Using Tilting Micromirrors*, 17(5) Journal of Lightwave Technology 904 (1999)

1005	U.S. Patent No. 6,442,307 to Carr et al.
1006	U.S. Patent No. 6,625,340 to Sparks et al.
1007	U.S. Patent Publication No. 2002/0081070 to Tew
1008	U.S. Provisional Patent Application No. 60/250,520 to Tew
1009	U.S. Patent No. 6,798,941 to Smith et al.
1010	U.S. Provisional Patent Application No. 60/234,683 to Smith et al.
1011	J. Alda, "Laser and Gaussian Beam Propagation and Transformation," in *Encyclopedia of Optical Engineering*, R. G. Driggers, Ed. Marcel Dekker, 2003, pp. 999–1013 ("Alda")
1012	Joint Claim Construction and Prehearing Statement, Capella Litigation, Case No. 3:14-cv-03348-EMC, Dkt. 151
1013	Newton's Telecom Dictionary (17th ed. 2001) (excerpted)
1014	Fiber Optics Standard Dictionary (3rd ed. 1997) (excerpted)
1015	Webster's New World College Dictionary (3rd ed. 1997) (excerpted)
1016	Declaration of Dr. Timothy Drabik
1017	Curriculum Vitae of Dr. Timothy Drabik
1018	U.S. Patent No. 6,253,001 to Hoen
1019	U.S. Patent No. 6,567,574 to Ma et al.
1020	U.S. Patent No. 6,256,430 to Jin et al.
1021	U.S. Patent No. 6,631,222 to Wagener et al.
1022	U.S. Patent No. 5,414,540 to Patel et al.
1023	U.S. Patent Publication No. 2002/0097956
1024	Shigeru Kawai, Handbook of Optical Interconnects (2005) (excerpted)
1025	U.S. Patent No. 6,798,992 to Bishop et al.

1026	Joseph W. Goodman, Introduction to Fourier Optics, Second Edition, McGraw-Hill (1996)
1027	U.S. Patent No. 6,204,946 to Aksyuk et al.
1028	L.Y. Lin, "Free-Space Micromachined Optical Switches for Optical Networking, *IEEE Journal of Selected Topics In Quantum Electronics*," Vol. 5, No. 1, pp. 4–9, Jan./Feb. 1999
1029	S.-S. Lee, "Surface-Micromachined Free-Space Fiber Optic Switches With Integrated Microactuators for Optical Fiber Communications Systems," in *Tech. Dig. 1997 International Conference on Solid-State Sensors and Actuators*, Chicago, June 16-19, 1997, pp. 85–88
1030	H. Laor, "Construction and performance of a 576×576 single-stage OXC," in Tech. Dig. LEOS '99 (vol. 2), Nov. 8–11, 1999, pp. 481–482
1031	R. Ryf, "1296-port MEMS Transparent Optical Crossconnect with 2.07 Petabit/s Switch Capacity," in *Tech. Dig. OSA Conference on Optical Fiber Communication*, March 2001, pp. PD28-1–PD28-3
1032	A. Husain, "MEMS-Based Photonic Switching in Communications Networks," in Tech. Dig. OSA Conference on Optical Fiber Communication, 2001, pp. WX1-1–WX1-3
1033	U.S. Patent No. 5,661,591 to Lin et al.
1034	H. Laor et al., "Performance of a 576×576 Optical Cross Connect," *Proc. of the Nat'l Fiber Optic Engineers Conference*, Sept. 26-30, 1999
1035	V. Dhillon. (2012, Sep. 18). Blazes and Grisms. Available: http://www.vikdhillon.staff.shef.ac.uk/teaching/phy217/instrument s/ph y217_inst_blaze.html ("Dhillon")
1036	Fianium Ltd. WhiteLase SC480 New Product Data Sheet. Available: http://www.fianium.com/pdf/WhiteLase_SC480_BrightLase_v1.p df. ("Fianium")
1037	Declaration of Dr. Joseph E. Ford
1038	Curriculum Vitae of Dr. Joseph E. Ford
2001	Patent Owner Response, Cisco Systems, Inc. v. Capella Photonics, Inc., Case IPR2014-01166, filed May 7, 2015

2002	Clifford Holliday, Components for R-OADMs ’05 (B & C Consulting Services & IGI Consulting Inc. 2005). (“Holliday ROADMs”)
2003	WavePath 4500 Product Brief, accessed at http://www.capellainc.com/downloads/WavePath%204500%20Product%20Brief%20030206B.pdf. (“WavePath”)
2004	Cisco’s Renewed Motion and Memorandum in Support of Motion for Stays Pending Final Determinations of Validity by the Patent Office, *Capella Photonics, Inc. v. Cisco Systems, Inc.*, Case No. 14-cv-03348-EMC (N.D. Cal.), filed February 12, 2015. (“Cisco’s Mot. for Stay”)
2005	Order Regarding Cisco’s Pending Motion for Litigation Stay Pending *Inter Partes* Review, *Capella Photonics, Inc. v. Cisco Systems, Inc.*, Case Nos. 14-cv-03348-EMC, 14-cv-03350, and 14-cv-3351 (N.D. Cal.), ordered March 3, 2015. (“14-cv-03348 Slip op.”)
2006	U.S. Patent No. 6,768,571 to Azarov et al. (“Azarov”)
2007	The Random House Dictionary of the English Language, 1987, pp. 404, 742 (“Random House Dictionary”)
2008	Provisional Patent Application No. 60/267,285 (“’285 provisional”)
2009	Transcript of Patent Trial and Appeal Board Conference Call for Cases IPR2014-01166 (merged with IPR2015-00816), IPR2014-01276 (merged with IPR2015-00894), IPR2015-00726, and IPR2015-00727, dated September 23, 2015
2010	Transcript of Patent Trial and Appeal Board Conference Call for Cases IPR2015-00726 and IPR2015-00727, dated October 29, 2015
2011	Redline Comparison of Paragraph 155 of Drabik Declaration (Ex. 1016) and Ford Declaration (Ex. 1037)
2012	Provisional Patent Application No. 60/277,217 (“’368 Provisional”)
2013	John C. McNulty, *"A perspective on the reliability of MEMS-based components for telecommunications"*, Proc. SPIE 6884, Reliability, Packaging, Testing, and Characterization of MEMS/MOEMS VII, 68840B (February 18, 2008)

2014	*Capella Photonics Launches Dynamically Reconfigurable Wavelength Routing Subsystems, Offering Unprecedented Operating Cost Savings and Flexibility for Telecom Service Providers*, Business Wire (June 2, 2003, 8:16 AM), http://www.businesswire.com/news/home/20030602005554/en/Capella-Photonics-Launches-Dynamically-Reconfigurable-Wavelength-Routing ("Business Wire")
2015	Benjamin B. Dingel & Achyut Dutta, *Photonic Add-Drop Multiplexing Perspective for Next Generation Optical Networks*, 4532 SPIE 394 (2001) ("Dingel")
2016	Tze-Wei Yeow, K. L. Eddie Law, & Andrew Goldenberg, *MEMS Optical Switches*, 39 IEEE Comm. I Mag. no. 11, 158 (2001) ("Yeow")
2017	Patrick B. Chu et al., *MEMS: the Path to Large Optical Crossconnects*, 40 IEEE Comm. I Mag. no. 3, 80 (2002) ("Chu")
2018	Clifford Holliday, *Switching the Lightwave: OXC's – The Centerpiece of All Optical Network* (IGI Consulting Inc. & B & C Consulting Services 2001) ("Holliday OXC")
2019	An Vu Tran et al., *Reconfigurable Multichannel Optical Add-Drop Multiplexers Incorporating Eight-Port Optical Circulators and Fiber Bragg Gratings*, 13 Photonics Tech. Letters, IEEE, no. 10, 1100 (2001) ("Tran")
2020	Jungho Kim & Byoungho Lee, *Bidirectional Wavelength Add- Drop Multiplexer Using Multiport Optical Circulators and Fiber Bragg Gratings*, 12 IEEE Photonics Tech. Letters no. 5, 561 (2000) ("Kim")
2021	Max Born & Emil Wolf, Principles of Optics (Pergamon Press, 6th Corrected Ed. 1986) (Excerpts) ("Born")
2022	Fraine, D.S. Simon, O. Minaeva, R. Egorov, and A.V. Sergienko, *Precise evaluation of polarization mode dispersion by separation of even- and odd-order effects in quantum interferometry*, Optics Express v. 19, no. 21, 22820 (2011) ("Fraine")
2023	Abdul Al-Azzawi, Fiber Optics: Principles and Practices (CRC Press 2006) ("Al-Azzawi")
2024	Curriculum Vitae of Dr. Alexander V. Sergienko ("Sergienko CV")

2025	Ming C. Wu, Olav Solgaard and Joseph E. Ford, “Optical MEMS for Lightwave Communication,” Journal of Lightwave Technology, Vol. 24, No. 12, Dec. 2006, pp. 4433-4454
2026	Deposition Transcript of Dr. Joseph E. Ford
2031	U.S. Patent No. 6,178,284 to Bergmann & Joseph E. Ford et al.
2034	Joseph E. Ford, Ph.D., Hand Drawing, Exhibit No. 5 for Deposition of Joseph E. Ford, Ph.D., Taken December 11, 2015
2035	U.S. Patent No. 6,984,917 to Greywall & Marom
2036	U.S. Patent No. 6,178,033 to Joseph E. Ford et al.
2037	U.S. Patent No. 6,859,573 to Bouevitch et al.
2038	J. E. Ford, Optical MEMS: *Legacy of the telecom boom*, Solid-State Sensor, Actuator and Microsystems Workshop, Hilton Head, SC, Jun. 6-10 (2004)
IPR Ex. 2009	Holliday “OXC Components for R-OADMS” (2005). B & C Consulting Services

17. This declaration represents opinions I have formed to date. I may consider additional documents as they become available or other documents that are necessary to form my opinions. I reserve the right to revise, supplement, or amend my opinions based on new information and on my continuing analysis.

OVERVIEW OF THE LAW USED FOR THIS DECLARATION

18. When considering the Asserted Patents and stating my opinions, I am relying on legal principles that have been explained to me by counsel.

19. I understand that for a claim to be found patentable, the claims must be, among other requirements, novel and nonobvious from what was known at the time of the invention, *i.e.*, the earliest alleged priority date of the Asserted Patents – March 19, 2001.

A. Level of Skill in the Art

20. I have been asked to consider the level of ordinary skill in the art that someone would have had in 2001. With over 30 years of experience in physics and optical communications, I am well informed with the level of ordinary skill, which takes into consideration:

- Levels of education and experience of persons working in the field;
- Types of problems encountered in the field; and
- Sophistication of the technology.

21. Based on the technologies disclosed in the ’678 patent and the considerations listed above, a person having ordinary skill in the art (“POSA”) would have had a Master of Science degree in Electrical Engineering, Physics, or an equivalent field, as well as at least three years of industry experience designing optical systems. Less education could be compensated by more direct experience and vice versa.

22. Throughout this declaration, even if I discuss my analysis in the present tense, I am always making my determinations based on what a POSA would have known at the effective filing date. Additionally, throughout this declaration, even if I discuss something stating “I,” I am referring to a POSA’s understanding.

B. Claim Construction

23. I understand that, in this proceeding, the claims must be given their correct meaning in view of the patent specification (including the claims), the file history, and extrinsic evidence. I also understand that the U.S. Patent Trial and Appeal Board (“PTAB”) and the U.S. Patent and Trademark Office (“USPTO”), during the prosecution, IPRs and reissues, gave the patent claims their broadest reasonable interpretation consistent with the specification.

24. I understand that district courts examine claims to determine the construction that most accurately delineates the scope of the invention in view of the specification, file history, and other extrinsic evidence of record. *Phillips*, *supra*, 415 F.3d at 1314. This "correct" construction may be significantly narrower than the interpretation of the claims by USPTO, where the PTAB seeks to find the "broadest reasonable interpretation" (BRI) of the claims.

25. I understand that the Federal Circuit explained in *PPC Broadband, Inc. v. Corning Optical Communications RF LLC* 815 F.3d 734, 740-43 (Fed. Cir. 2016) that different claim constructions are likely to arise with frequency as a result of the different standards. I understand they stated the following:

> Under *Cuozzo*, the Patent and Trademark Office ("PTO") gives claim language its broadest reasonable interpretation in IPRs. ... Historically, the PTO applied this standard in the examination and reexamination of patents, where the applicant may freely amend the claim language to clarify the scope of the claim. … While broadly construing claim language increases the likelihood that otherwise distinguishable prior art will render the claimed invention anticipated or obvious, the patentee can amend the claim language during prosecution—and narrow it if necessary—to clarify the scope of the invention and avoid rejection or cancellation of the claims. District courts, by contrast, do not assign terms their broadest reasonable interpretation. Instead, district courts seek out the correct construction—the construction that most accurately delineates the scope of the claimed invention—under the framework laid out in *Phillips v. AWH Corp*., 415 F.3d 1303 (Fed. Cir. 2005) (*en banc*). The same is true of reexaminations before the PTO when claims have expired, and therefore may not be amended. *In re Rambus, Inc*., 753 F.3d 1253, 1256 (Fed. Cir. 2014).
>
> In 2011, Congress enacted the America Invents Act ("AIA"), Pub. L. No. 112-29, 125 Stat. 284 (2011). The AIA created several new adjudicatory proceedings before the PTO for determining the patentability of already issued patent claims. These proceedings include IPRs, post-grant reviews, and covered business method reviews ("CBMs"). IPRs are the proceedings at issue here.
>
> Despite the important differences between the new AIA proceedings and the earlier examinational proceedings, the PTO applies the same claim construction standard—the broadest reasonable interpretation—in both types of proceedings. We upheld this approach in *Cuozzo*, a decision currently under review by the Supreme Court. *Cuozzo*, 793 F.3d 1268, cert. granted, 84 U.S.L.W. 3218.

This case hinges on the claim construction standard applied—a scenario likely to arise with frequency. And in this case, the claim construction standard is outcome determinative. Under *Phillips*, we would hold that the correct construction of the term "continuity member" requires, as PPC Broadband argues, a continuous or consistent connection. The American Heritage College Dictionary (4th ed. 2002) defines "continuity" as "1. The state or quality of being continuous. 2. An uninterrupted succession or flow; a coherent whole." J.A. 2967.

Furthermore, the specification discloses in multiple places that the continuity member should maintain a consistent and continuous connection. … In light of the ordinary meaning of "continuity" and the specification, which is replete with discussion of the "continuous" or "consistent" contact established by the continuity member, the correct construction of "continuity member" under the framework laid out in *Phillips*, 415 F.3d 1303, requires "consistent or continuous contact with the coupler/nut and the post to establish an electrical connection."

However, claim construction in IPRs is not governed by *Phillips*. Under *Cuozzo*, claims are given their broadest reasonable interpretation consistent with the specification, not necessarily the correct construction under the framework laid out in *Phillips*. *Cuozzo*, 793 F.3d at 1279. Here, the Board's construction is not unreasonable.

While the ordinary meaning of "continuity" and "continuous" often refers to something that is uninterrupted in time, these terms can also refer to something that is uninterrupted in space. See J.A. 2967 (defining "continuous" as "1. Uninterrupted in time, sequence, *substance*, or *extent*" (emphasis added)). …

Under the Board's construction, there is no requirement of consistent or continuous contact through the post and the nut. Because the Board's construction does not include this additional temporal limitation, it is broader than PPC Broadband's proposed construction. Thus, ***while the Board's construction is not the correct construction*** under *Phillips*, ***it is the broadest reasonable interpretation of "continuity member,"*** and because this is an IPR, under our binding precedent, we must uphold the Board's construction of "continuity member" and "electrical continuity member." [emphasis added].

PPC Broadband, *supra*, at 740-743 (emphasis added).

TECHNOLOGY

A. General Overview

26. Telecommunication companies use optical fiber to transmit and receive communication signals for the telephone, cable television, and the Internet. Optical fiber enables

various wavelengths of light to simultaneously travel along each optical fiber. Each of the various wavelengths carries data intended for delivery to a specific location on a network. In fiber-optic communications, the use of multiple wavelengths is referred to as wavelength-division multiplexing ("WDM"). WDM is an approach that multiplexes a number of optical carrier signals onto a single optical fiber by using different wavelengths of light. Such an approach enables bidirectional communications over each strand of optical fiber, as well as enabling the expansion of the data carrying capacity of that strand. The WDM approach is particularly useful for telecommunications companies because the WDM approach allows these companies to expand the capacity of the network without the cost of laying additional fiber. Capacity of a given optical fiber link can thereby be expanded by simply upgrading the multiplexers and demultiplexers at each end of the optical fiber link. Thus, WDM allows telecommunications companies to accommodate more than one generation of technology development in their optical infrastructure without having to overhaul the optical fiber backbone network. However, WDM poses several technical challenges as the optical switching is more complicated due to the number of optical signals present. Specifically, in a WDM network, each spectral channel must be individually routable to a desirable location.

27. To service many locations, optical fiber networks form a grid spanning across the country. Line segments of optical fiber cable intersect at nodes or hubs, and the nodes or hubs have switching devices to redirect signals, add signals, and drop signals. The ability to add and drop signals requires the use of an optical add-drop multiplexer ("OADM").

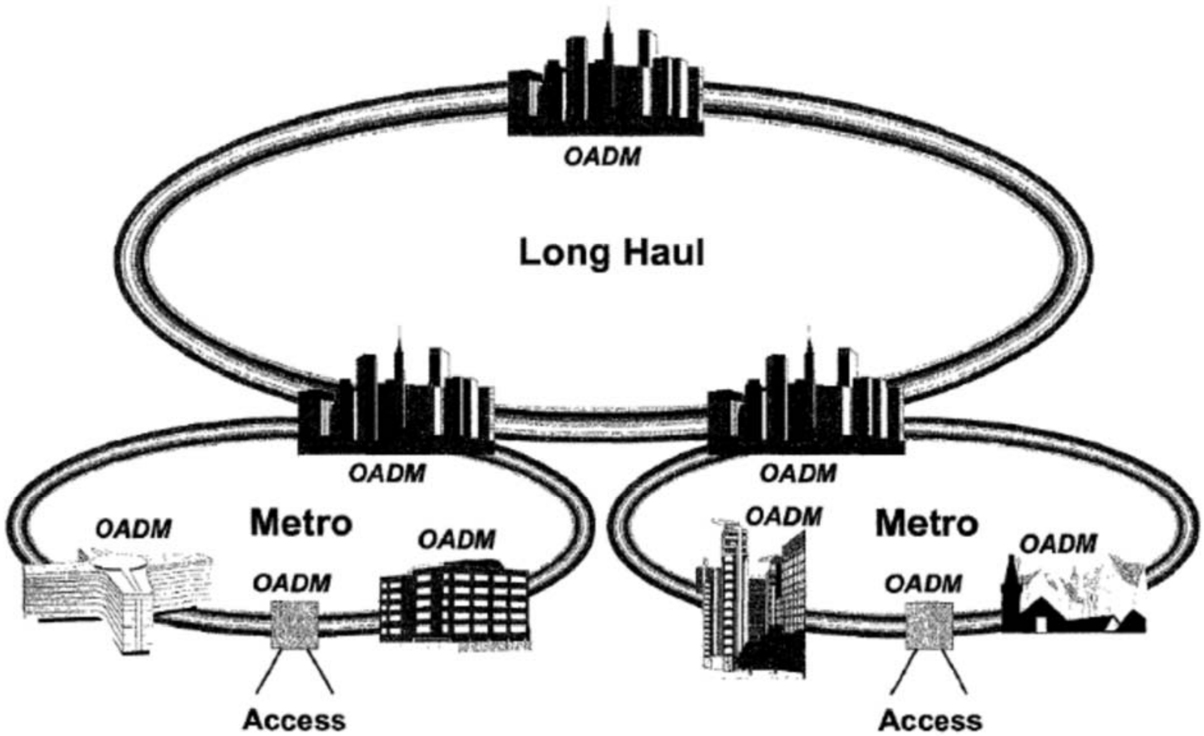
28. An OADM is a device used in WDM systems for multiplexing and routing different channels of light into or out of a single optical fiber. Thus, an OADM device is an example of optical node that is an important component of optical telecommunications networks.

"Add" in the term "add-drop" refers to the capability of the OADM device to add one or more new wavelength channels to an existing WDM signal, while "drop" refers to the removal of one or more channels from the existing WDM signal. Those "dropped" channels are passed onto another network path for subsequent processing or routing.

29. At the time of the invention, a conventional OADM typically consisted of three stages: an optical de-multiplexer, an optical multiplexer, together with a means of reconfiguration placed between the optical de-multiplexer and the multiplexer. The de-multiplexer separates wavelength channels from an input fiber onto ports. The reconfiguration can be achieved by, for example, optical switches which direct the wavelength channels to the multiplexer or to the drop ports. The multiplexer multiplexes the wavelength channels that are to continue on from demultiplexer ports with those from the add ports, onto a single output fiber.

30. At the time of the invention, there were several ways to realize an OADM. There are a variety of de-multiplexer and multiplexer technologies including optical circulators, free space grating devices, and integrated planar arrayed waveguide gratings. The switching or reconfiguration functions include a variety of switching technologies, including microelectromechanical systems (MEMS) devices.

31. The figure (reproduced below) shows how OADMs, or alternatively reconfigurable optical add drop multiplexers ("ROADM"), interconnect different optical networks. (*See* '678 Provisional, IPR2015-00727, Ex. 2012, FIG. 2).



32. As alluded to above, OADMs are the backbone of advanced fiber optic networks because switching is accomplished in the optical domain by OADMs. Multiple optical fibers may connect to ports of an OADM, and OADMs can switch wavelengths among optical fibers connected to its ports. OADMs can switch signals traveling along fiber optic cables, redirect signals to different endpoints, add and drop signals, and control traffic flow.

33. In reference to the figure shown above, an OADM may connect a wide area (or long haul) network to a metropolitan area network. Another OADM may connect a metropolitan area network to a local access network, for example a local network in a neighborhood. During switching, OADMs can separate all the wavelengths of light entering the device and route the wavelengths of light to different endpoints depending on the OADM's configuration. An OADM may, for example, switch wavelengths from optical fibers of the wide area network to optical fibers of a metro area network. An OADM may also switch wavelengths from optical fibers of a metro area network to optical fibers of a wide area network.

34. OADMs can drop certain wavelengths from a fiber altogether, and can add new wavelengths to a fiber. Further, OADMs can control traffic flow across fiber optic cables. If traffic along one cable is particularly heavy at certain times, OADMs can manage the load by redirecting traffic along different fibers.

35. In addition to switching, add/drop, and traffic control capabilities, OADMs have the ability to control the output power. As a result, OADMs provide high uniformity or equalization in the channels' power across all-optical networks. One way OADMs control power output is through deliberate misalignment of the light beam to an output waveguide. Misalignment controls power by varying the coupling of the light beam to the optical waveguide. Angular misalignment changes the angle the light beam is incident to the optical waveguide, and lateral misalignment reduces the portion of the beam that can enter the output waveguide.

36. Another way OADMs control power output is through manipulation of polarization and selective filtering.

37. To perform switching and power control, OADMs can use wavelength selective routers ("WSRs"). Certain WSRs perform switching and power control functions by steering light beams using beam-deflecting elements. Beam-deflecting elements can include, but are not limited to, small tilting mirrors commonly referred to as microelectromechanical systems ("MEMS"). MEMS mirrors can be used for switching. Varying the tilt of a MEMS mirror can reflect an incident light beam to a different output port. MEMS mirrors can also be used for power control. Varying the tilt of a MEMS mirror can control the coupling of a light beam to an output, effectively attenuating the light beam through a controllable amount of misalignment.

38. The tilt of MEMS mirrors is controllable, meaning it is capable of being controlled, by varying the control voltage applied to the mirrors. The tilt of these mirrors can be

adjusted to angles between the maximum and minimum angles of operation. The exact angles are determined by the applied voltages. At the time of the inventions, there were two approaches: (1) a digital (two-state – on/off) approach; and (2) an analog (many-state) approach. (*See* Holliday OXC Ex. 2009 at 18-19) attached hereto as Exhibit B.

39. The digital approach was extremely simple. The mirrors could be set to only two positions (hence the "digital" moniker) corresponding to "on" and "off" or pass and drop. The control circuit for these mirrors was easy to implement, but the switch itself had limited scalability. *Id. See also* U.S. Patent No. 5,946,116A (1997)(a copy is attached hereto as Exhibit C) ("First, the On and Off characteristics of each sub-element in the polarization rotator arrays are controlled digitally (e.g., "1" for On and "0" for Off). Second, there are a total of 2N output ports when N stages of birefringent elements and polarization rotator arrays are placed in series. Each of the stages produces two possible output directions. Based on these design concepts, a digitally programmable optical routing switch can be realized. A control state table is provided in Table 1.").

40. In the contrasting analog approach, the provided voltages allowed the mirrors to be set to many positions (hence the "analog" moniker). The control circuit for this analog approach was more complex, requiring voltage levels for each of the many positions, but the switch could be scaled with fewer mirrors and related components. One of ordinary skill in the art was familiar with the use of digital to analog converters.

41. Typical control systems for MEMs include digital to analog converters ("DACs") which provide analog control voltages to MEMs mirrors allowing the tilt to be set or adjusted to two or more intermediate positions. *See*, *e.g.*, https://www.mouser.com/datasheet/2/391/HV254-35296.pdf (a copy is attached hereto as Exhibit D).

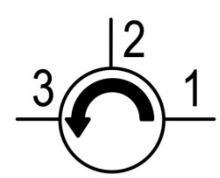
B. Use of Circulators at the Time of the Invention

42. At the time of the Asserted Patents' invention date, the demand for optical switching systems was increasing, even as much as 400% per year. (Holliday OXC, IPR2015-00727, Ex. 2018, p. 12). Bandwidth-heavy applications (*e.g.*, video streams) were becoming more popular, and optical fiber applications were reaching a wider populous. With an increase in demand for fiber optics, the ability to effectively switch data streams having multiple wavelengths, while accommodating an increase in optical input and output ports, became critical. Industry was trying to incorporate more ports while keeping costs down. As researchers published in 2001, the ability to provide an optical switch scalable to a large number of spectral channels was the number one concern for fiber optic carriers:

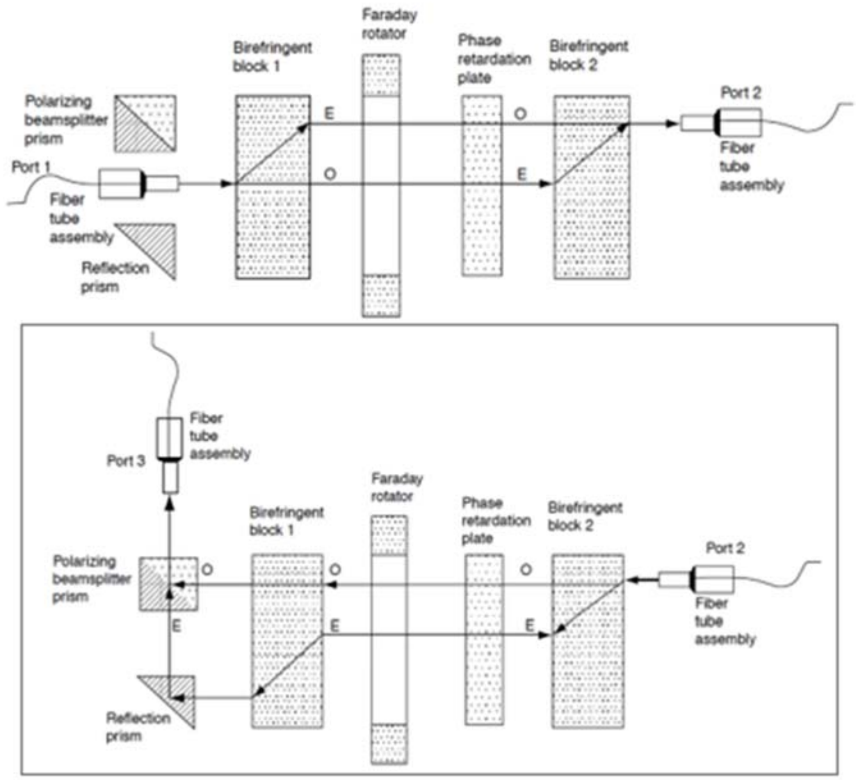
> The ability to incorporate more port counts when needed is the number one concern of carriers. The increasing amount of data traffic in communication networks, especially for long-distance carriers, will demand even more wavelengths to be deployed. Therefore, optical switches need the capability to scale in order to manipulate the increased number of wavelengths. MEMS-based optical switches must incorporate this key feature to gain widespread acceptance of the carriers.

(Yeow, IPR2015-00727, Ex. 2016, p. 163).

43. Many OADM systems at the time of the Asserted patents' invention date were limited to two ports. To separate incoming and outgoing optical signals on each port, OADM systems commonly used peripheral devices, such as optical circulators. Optical circulators are fiber-connected optical devices comprised of birefringent polarization elements that separate optical signals traveling in opposite directions. Typically, optical circulators have three circulator ports (*see* schematic diagram of an optical circulator, reproduced herein). Light entering a circulator port is emitted from the next circulator port. For example, light entering circulator port 1 is emitted from circulator port 2, light entering circulator port 2 is emitted from circulator port 3,



and light entering circulator port 3 is emitted from circulator port 1. This non-reciprocal redirection of light is achieved using collective operation of birefringent elements, a polarizing beam splitter, a reflector prism, a retardation plate, and a Faraday rotator unit. A typical optical circular schematic is reproduced below.



(Al-Azzawi, IPR2015-00727, Ex. 2023, Figures 6.14 & 6.15).

44. Optical fiber switching systems that used optical circulators had limited scalability. Multiple port circulators could be cascaded to create a chain of circulators. However, each added circulator increased the physical size of the system, contributed to insertion loss, and increased costs. *See* Dingel, IPR2015-00727, Ex. 2015, p. 399 (commenting that circulator price and circulator crosstalk, *i.e.*, signal interference, needs improvement).

45. Around the invention date of Asserted patents, systems also attempted to scale switching systems by concatenating OADMs together. However concatenating multiple

OADMs together substantially added bulk and cost to the system. Alternatively, other inventors were attempting to add ports to circulators. *See*, *e.g.*, Tran, IPR2015-00727, Ex. 2019 (disclosing a circulator with eight circulator ports); Kim, IPR2015-00727, Ex. 2020 (disclosing a circulator with six circulator ports). Yet, the use of circulators poses a number of disadvantages in that circulators merely separate optical signals traveling in opposite directions. For example, circulators cannot separate optical signals having different wavelengths. Instead, in order to separate optical signals having different wavelengths, multiplexers/demultiplexers are required as additional devices. Another problem with circulators is their non-reciprocity, since an optical signal cannot travel backwards on the same port as an optical signal traveling forwards. Such a disadvantage creates additional problems for networking architecture design, since one has to send signals around the network through other nodes instead of simply sending them back on the same fiber.

46. However these systems still had limited scalability. These circulators were bulky, expensive, and resulted in optical loss of signals moving through the optical circulator due to multiple reflections at surfaces of its birefringent optical components. *See* Al-Azzawi, IPR2015-00727, Ex. 2023, pp. 127-29. Thus, the industry needed an OADM system that eliminated the use of optical circulators, while providing a scalable multiple port switch.

47. The inventors of the Asserted Patents recognized the limitations of circulator-based optical switches. In the earliest provisional application, the inventors described an existing add/drop architecture with optical circulators (reproduced below with annotations). ('678 Provisional, p. 3). The inventors emphasized that the system had a number of limitations. *Id*. For example, the system required all the add and drop wavelengths to enter and exit the device on single fibers (*i.e.*, two ports). *Id*. And, an additional means would be required to multiplex

the add channels to the single fiber and to drop channels from the single fiber output. *Id*. As the inventors realized, the additional means, such as optical circulators, would lead to significant additional bulk and expense. *Id*.

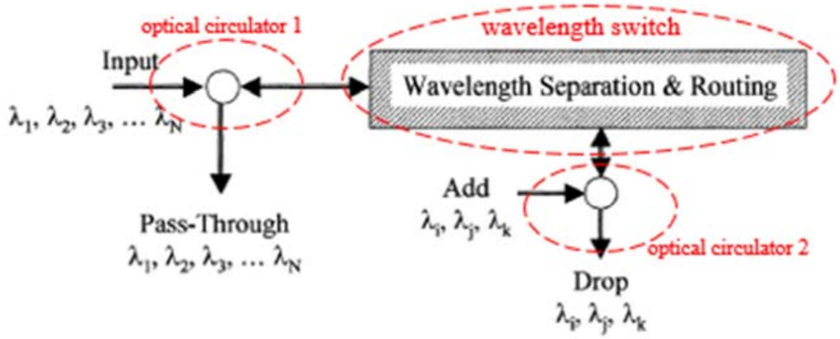


Figure 5

C. Use of MEMS Switches at the Time of the Invention

48. At times relevant to the invention (circa 2001) described in the ’678 patent, MEMS switches were not the component of choice in telecommunications systems. Persons of ordinary skill in the art recognized that for a telecommunications system to be feasible, it had to support the challenging requirements of Telcordia qualification standards. The converse was also true in that persons of ordinary skill in the art did not contemplate the use of components that could not support the “five nines” Telcordia reliability requirement. To a layperson, Telcordia’s “five nines” reliability requirement translates into 99.999% uptime, or a downtime of no greater than a 5-minute, 15-second period per year. MEMS switches, circa 2001, did not support such demanding provisions, nor was there any suggestion that success was likely to be achieved with the use of MEMS switches for anything other than the rudimentary “digital” two-state MEMS switch. In fact, it was not until many years later that MEMS switches showed any promise of meeting such demanding Telcordia requirements. Put another way, the MEMS switches of 2008 were not the MEMS switches of circa 2001, as it was not until much later that

the failure mechanisms of these devices were sufficiently understood. *See* IPR2015-00727, Ex. 2013, McNulty, Abstract.

D. Optical Components at the Time of the Invention

49. In analyzing the prior art, I have studied Dr. Ford's declaration (Fujitsu's IPR expert), his deposition, and Dr. Ford's invited paper (circa 2006). (IPR2015-00727, Ex. 2025). In particular, I was focused on the different paths that optical technology progressed at the timeframe of interest. Dr. Ford's 2006 invited paper accurately captures the different categories of optical components. In particular, as Dr. Ford's 2006 invited paper indicates, optical components were categorized into categories that included broadband optical switches, optical add/drop multiplexers, and wavelength selective switches. These different categories of components largely proceeded independently of each other, and continued to be considered separate categories of components, as of the 2006 timeframe of Dr. Ford's invited paper.

50. The first category of interest, the broadband switch, provides a switching capability that is independent of wavelength. In Section II.C of Dr. Ford's paper, he describes the particular characteristics of interest for such a broadband switch, where such technology is typically driven by the need for "digital" micro-mirrors (*i.e.*, 2-state mirrors). Switching may be achieved by either mirror angel changes or insertion of the mirror into the relevant optical path. Key design considerations are the reduction of diffraction loss, which impacts the physical sizing of such devices. The Sparks and Carr references describe early contributions to this broadband switch technology track.

51. The second category of interest is the Wavelength Add/drop Multiplexers, which are optical components that possess wavelength selective elements but have a limited number of physical ports for routing them to other parts of telecom network. Section III.B of Dr. Ford's

paper describes these optical components, and notes that these optical components rely on a diffraction grating for the wavelength selectivity. MEMS switches are again digital switches (*i.e.*, 2-state switches) that either return the incoming optical signal on the same path that it arrived upon, or the optical signal is tilted to another path. This category of optical component uses 2 ports – for each port, a circulator is added to separate the two directions of optical signals. Switches from the first category of interest are not useful for this second category of component because they do not possess a wavelength selection capability. The Bouevitch reference describes an early contribution to this wavelength add/drop multiplexer technology track.

52. Finally, the third category of interest is the wavelength selective switch that provides selectivity to multiple (*i.e.*, three, four, or more) neighboring nodes in a mesh network. Dr. Ford discusses these wave selective switches in Section III.C of his invited paper. Specifically, Dr. Ford notes that wavelength selective switches distinguish themselves as being able to direct different wavelengths to more than 2 ports. In this category of optical component, digital MEMS switches cannot be used – instead "analog" switches are required to satisfy the "more than 2 ports" configuration. Furthermore, a large continuous scan angle, high fill factor and two-axis micro-mirrors are required. Of the three categories analyzed here, wavelength selective switches were the most recent developments, as the cited references in Dr. Ford's paper demonstrate. Specifically, Dr. Ford's references ([80] through [90]) reflect the reality of developments in the optical industry, namely that wavelength selective switches were not described or available in the prior art, *i.e.*, before the priority date of the '678 patent. In fact, the '678 patent is the earliest contribution to this wavelength selective switch technology track, and Dr. Ford's own 2006 analysis verifies this fact.

OVERVIEW OF THE ASSERTED PATENTS

53. In this section I provide insight on how the technology disclosed in the Asserted Patents addresses the technical challenges in the field at the time of the invention. This will help put certain claim terms of the Asserted Patents in context and help determine what a POSA would have understood during the 2001 timeframe (*i.e.*, the effective filing date).

A. The Asserted Patents

54. The Asserted Patents disclose a scalable ROADM for optical switching. The ROADM is scalable because the system can increase capabilities to a large number of spectral channels. As previously noted, there was a growing demand for scalable fiber-optic communication networks at the time of the Asserted Patents' invention date. *See* '678 patent, 1:32-36, 2:14-18; Yeow, IPR2015-00727, Ex. 2016, p. 163; Chu, IPR2015-00727, Ex. 2017, p. 81 ("scalability is a paramount concern"). Fiber-optic systems at the time were not scalable because: (1) adding system capabilities required additional expensive components; (2) the systems were required to be pre-configured on an application-by-application basis; and (3) the systems comprised multiple segments of MEMS arrays (*e.g.*, 4x4 mirror segments).

55. Adding components limited a system's scalability to a large number of channels because more components, such as circulators and external wavelength multiplexers/ demultiplexers, resulted in higher costs. *See* '678 patent, 2:49-54, 3:45-46. A fiber optics system also loses efficiency when more components are used because each component contributes to a cumulative and undesired optical loss. *See id.*, 2:54-57. Further, systems were limited in scalability because they were required to be pre-configured on an application-by-application basis. The systems were neither dynamically configurable nor capable of self-correction in real-time. *See id.*, 2:57-64 ("There are . . . no provisions provided [in the prior art]

for maintaining the requisite alignment; and no mechanisms implemented for overcoming degradation in the alignment owing to environmental effects such as thermal and mechanical disturbances over the course of operation"), 3:14-19, 3:20-23, 3:27-31.

56. To address these issues, the inventors of the Asserted Patents recognized that continuous control of beam-deflecting elements, such as micromirrors, could enable reflection to multiple spectral output ports without using circulators. *See id.*, 4:8-15. Continuous is used in the ordinary sense (according to Webster's Dictionary: "marked by uninterrupted extension in space, time, or sequence") to indicate constant or active control of the elements to allow the channel micromirror to scan its corresponding spectral channel across all possible output ports – a major improvement over two-state "digital" systems.

57. The inventors aligned a plurality of ports, a diffraction grating, a lens, and a micromirror array in a configuration capable of directing an input light beam to multiple output ports. *See id.,* FIG. 1A. In a preferred embodiment, constant or continuous control of channel micromirrors allowed the position of the mirror to be continuously adjusted to direct corresponding channels to all possible output ports.

> As described above, a unique feature of the present invention is that the motion of each channel micromirror is individually and continuously controllable, such that its position, e.g., pivoting angle, can be continuously adjusted. This enables each channel micromirror to scan its corresponding spectral channel across all possible output ports and thereby direct the spectral channel to any desired output port.

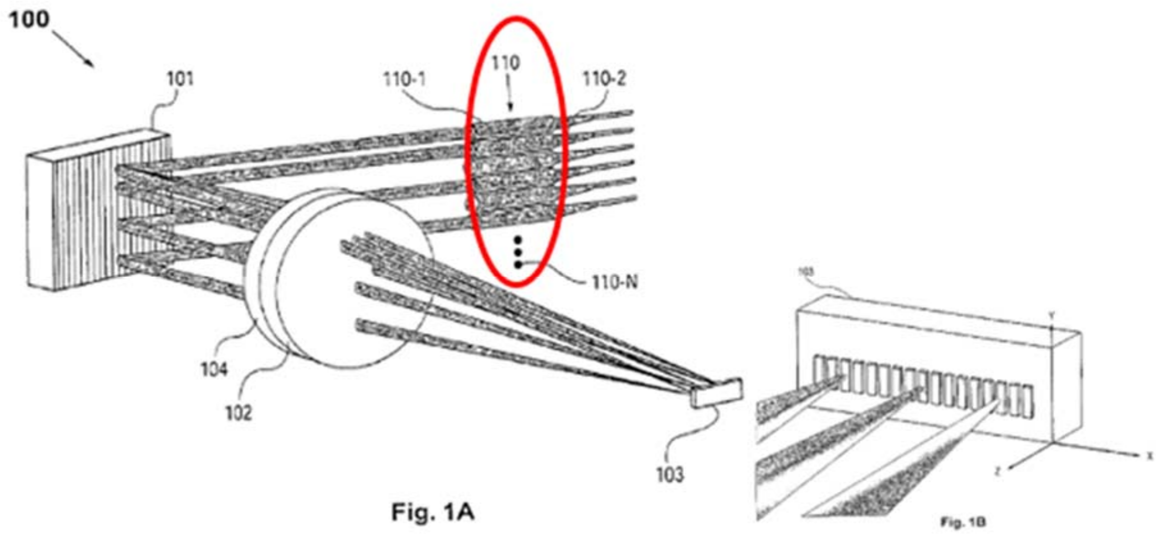
('905 patent, 8:38-45; '906 patent, 8:50-57).

58. The configurations disclosed in the Asserted Patents not only enabled dynamic switching, but also reduced the number of components required to scale a system. For example, the system only needed limited components to add an additional input to the system or accommodate an additional output from the system. *See* Holliday R-OADMs, IPR2015-00727,

Ex. 2002, p. 61 ("Capella's WavePath product line enables system architects to design optical platforms that offer dynamic and remote reconfigurability, thus greatly simplifying the engineering and provisioning of optical networks."); Business Wire, IPR2015-00727, Ex. 2014, p. 2 ("The introduction of dynamic reconfigurability will enable service providers to drastically reduce operating expenses associated with planning…by offering remote and dynamic reconfigurability"). It is my understanding that the '678 patented technology is incorporated into the WavePath product line described in the Clifford Holliday and Business Wire references. *See, e.g.,* WavePath, IPR2015-00727, Ex. 2003, pp. 1, 4.

59. Allowing any individual spectral channel to be directed to any desired output port is enabled by the selective activation of MEMS mirrors without disrupting the existing configuration. *See generally* '678 patent. As stated in the '678 patent, "the underlying OADM architecture thus presented is intrinsically scalable and [is a system that] can be readily extended." ('678 patent, 5:36-40; *see also* FIG. 1A (showing how additional output ports can be added at 110-N)).

60. The embodiment shown in Figures 1A and 1B (both reproduced below) show the features of the '678 patent. The ROADM disclosed in the '678 patent has an array of micromirrors that are individually controllable to reflect individual wavelength spectral channels into a selected output port among a plurality of ports. *Id.* at Abstract ("channel micromirrors are individually controllable and continuously pivotable to reflect the spectral channels into selected output ports"). The system has a diffraction grating 101 to both demultiplex and multiplex a light beam and a focusing lens 102 to focus the light beam's wavelengths to the micromirrors.



61. The system also has, as circled in red above, multiple collimators 110 serving as the structure for the input and output ports for the system. *See id.*, 6:52-63, FIG. 1A. Additional collimators (*i.e.*, ports) could be added at 110-N. *See id.*

62. The configuration of multiple ports, a lens, and a micromirror array forms a WSR system that can route multiple spectral channels on a channel-by-channel basis. *Id.* at Abstract. A multiple wavelength light beam is sent through the input port and impinges on the diffraction grating to demultiplex the light beam into individual wavelengths. *Id.*, 6:64-7:11. The individual wavelengths then diffract off the diffraction grating toward the lens. *Id.* The lens focuses the individual wavelengths of light to different mirrors along the micromirror array. *Id.*

63. A unique feature of the preferred micromirror embodiment of the Asserted patents is that each micromirror is individually and continuously controllable in two axes. *Id.*, 8:21-27 & 9:8-9. Specifically, the mirror's controllable position (*e.g.*, pivoting angle) can reflect the spectral channel to any desired output port. *Id.* So, because the individual wavelengths are focused onto different mirrors along the micromirror array and each micromirror is individually

and continuously controllable, the tilt of each micromirror reflects the individual wavelengths back along a selected path to a desired output among the multiple ports. *Id.*, 6:64-7:11.

64. As stated in the Asserted Patents,

> [A] multi-wavelength optical signal emerges from the input port 110-1. The diffraction grating 101 angularly separates the multi-wavelength optical signal into multiple spectral channels, which are in turn focused by the focusing lens 102 into a spatial array….The channel micromirrors 103 are positioned…such that each channel micromirror receives one of the spectral channels. The channel micromirrors 103 are individually controllable and movable, *e.g.*, pivotable (or rotatable) under analog (or continuous) control, such that, upon reflection, the spectral channels are directed into selected ones of the output ports 110-2…by way of the focusing lens 102 and the diffraction grating 101.

('905 patent, 7:9-25; '906 patent, 7:23-37).

65. Another embodiment depicted in Figure 3 (reproduced below) includes a two-dimensional WSR system with a two-dimensional array of ports 350 instead of a one-dimensional array of ports. *Contra* id., FIG. 3 with *Id.*, FIG. 1A, 110. The two-dimensional system shown in Figure 3 includes two-dimensional arrays 360 and 370 of imaging lenses and collimator-alignment mirrors 320. *See id.*, 10:25-38. Again, fiber collimators "provid[e] for an input-port and a plurality of output ports." *Id.*, 10:29-32.

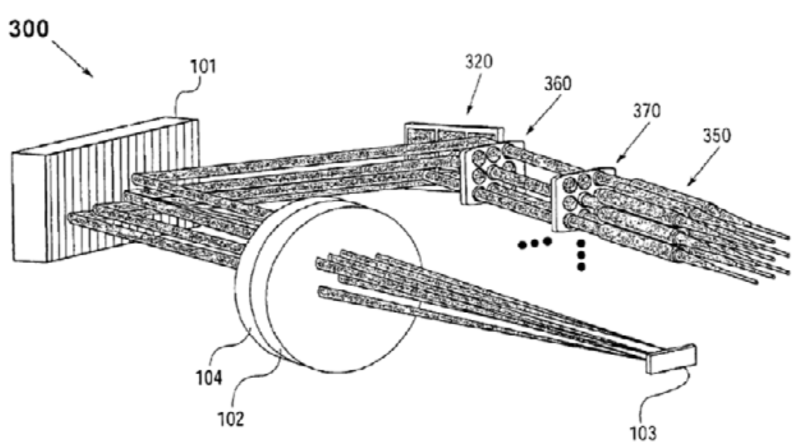


Fig. 3

66. In the embodiment shown in Figure 3, the channel micromirrors within the micromirror array 103 are pivotable biaxially to direct their corresponding spectral channel to any one of the output ports 350. *Id.*, 10:43-47. Thus, the two-dimensional WSR apparatus 300 can support even a greater number of ports than the one-dimensional WSR system shown in Figure 1A. *Id*.

67. The continuously controllable mirrors disclosed in the '678 patent are used not only for switching but also for power control. *See id.*, 8:28-36. The system controls power by altering the coupling efficiency of the spectral channels into the respective output ports. *See id*. The coupling efficiency is defined as the ratio of the amount of optical power that is coupled into the output port's fiber core to the total amount of optical power from the light beam. *Id.*, 8:31-36.

68. To monitor power, embodiments of the Asserted patents utilize servo-control. *See id.*, 4:47-56, 11:52-57. The specification states that "[t]o optimize the coupling of the spectral channels into the output ports and further maintain the optimal optical alignment against environment[al] effects such as temperature variations and mechanical instabilities over the course of operation, a WSR apparatus…may incorporate a servo-control assembly, for providing dynamic control of the coupling of the spectral channels into the respective output ports on a channel-by-channel basis." *Id.*, 10:62-11:2. An embodiment of the servo-control assembly is depicted in Figure 4A (reproduced below).

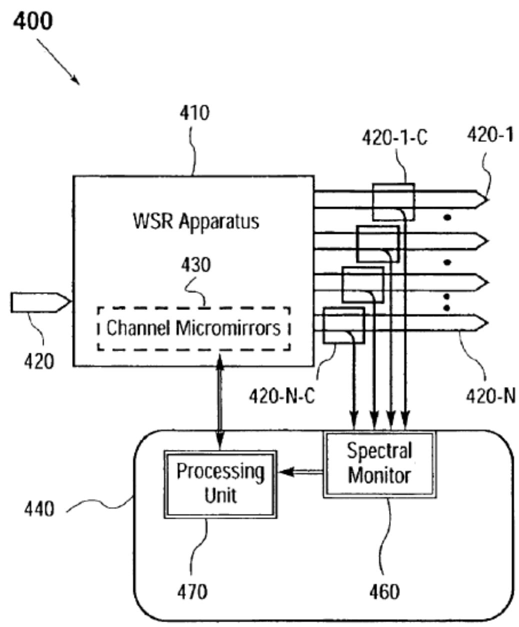


Fig. 4A

69. Figure 4A comprises a WSR apparatus 410 and a servo-control assembly 440. *Id.*, 11:5-8. A spectral monitor 460 monitors the power levels of the spectral channels. *Id.*, 11:10-13. A processing unit 470 provides feedback control to the channel micromirrors 430 on a channel-by-channel basis to maintain a desired coupling efficiency for each channel into a selected output port. *Id.*, 11:21-26. The servo-control assembly provides dynamic power control for a spectral channel into its respective output port. *Id.*, 11:26-30. Such power management enables the system to be dynamically managed according to demand or dynamically equalized at a predetermined value. *Id.*, 11:30-34.

70. Ultimately, the technology disclosed in the Asserted Patents addressed the problem of limited scalability. As recognized, "Capella's WavePath product line [(technology of which is disclosed in the Asserted Patents)] enables system architects to design optical platforms that offer dynamic and remote reconfigurability, thus greatly simplifying the engineering and

provisioning of optical networks." (Holliday R-OADMs, IPR2015-00727, Ex. 2002, p. 61). It was also recognized that "[t]he Capella WavePath family delivers a high level of functional integration resulting in an extremely cost effective subsystem solution. WavePath…integrates ten typically discrete functions into a single module making reconfigurability essentially free. Capella is the only company to offer a 10-fiber port solution, *i.e.*, one input, one express output, and 8 service ports. The service ports may be configured as either drop or add depending on the application." *Id*.

B. The Bouevitch Patent

71. I have analyzed U.S. Patent No. 6,498,872 ("Bouevitch") and noted the following issues: (1) Bouevitch's Figure 11 has only two ports, and therefore needs a circulator; (2) Bouevitch discloses two distinct modifying means; and (3) Bouevitch's Figure 11 does not control power.

INDEPENDENT CLAIM ELEMENTS

Fiber Collimators, Providing an Input Port and a Plurality of Output Ports

72. As disclosed in the specification and shown in Figure 1A of the '678 patent (reproduced below), the WSR apparatus comprises an input port 110-1 and a plurality of output ports 110-2 through 110-N. ('678 patent, 6:56-60). In the embodiments in the '678 patent, the structure or elements making up the ports are collimators. The collimators serve as input port for a multi-wavelength optical signal 110-1 and the plurality of output ports for a multi-wavelength optical signal 110-2 through 110-N. *Id.*, 3:54-58, 4:26-28. One collimator serves as one input port for one or many wavelengths. The system also has at least five collimators serving as five output ports for any one or combination of wavelengths. Additional ports can be added at 110-N

by adding collimators. So, the collimators serve as the input and output ports in a one-to-one relationship.

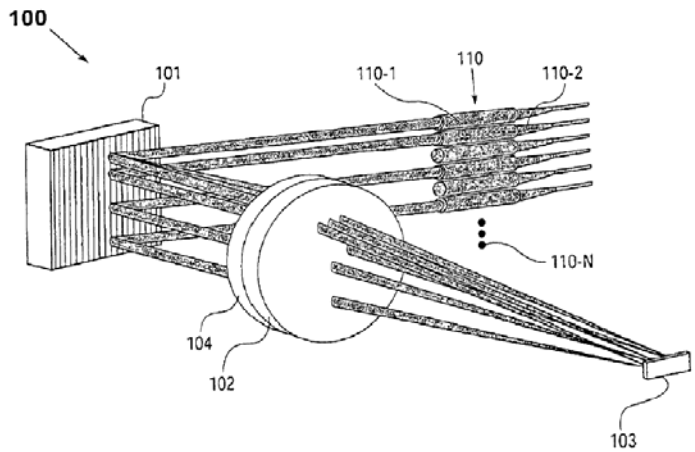


Fig. 1A

73. A POSA would view Figure 1A as disclosing the fiber collimators, providing an input port and a plurality of output multi-wavelength ports. In fact, in the same year the USPTO originally issued the ’678 patent, a consultant report said that “Capella is the only company to offer a 10-fiber port solution, *i.e.*, one input, one express output, and 8 service ports.” (Holliday R-OADMs, IPR2015-00727, Ex. 2002, p. 61).

74. Independent claims 1 and 21 of the ‘678 patent recite “multiple fiber collimators, providing an input port for a multi-wavelength optical signal and a plurality of output ports.”

75. Independent claim 44 of the ‘678 patent recites “an array of fiber collimators, providing an input port for a multi-wavelength optical signal and a plurality of output ports including a pass-through port and one or more drop ports.”

76. Independent claim 61 of the ‘678 patent recites “receiving a multi-wavelength optical signal from an input port” and “direct said spectral channels into any selected ones of said output ports.”

77. The independent claims of the ‘678 patent were cancelled in the IPR proceedings and appear in the ‘906 patent printed with strikethrough.

78. Independent claims 1 of the ‘368 patent recite “an input port for an input multi-wavelength optical signal having first spectral channels; one or more other ports for second spectral channels; an output port for an output multi-wavelength optical signal.”

79. Independent claims 16 of the ‘368 patent recite “an input port for an input multi-wavelength optical signal having multiple spectral channels; an output port for an output multi-wavelength optical signal; one or more drop ports for selected spectral channels dropped from said multi-wavelength optical signal.”

80. The independent claims of the ‘368 patent were cancelled in the IPR proceedings and appear in the ‘905 patent printed with strikethrough.

CLAIM CONSTRUCTIONS

A. Legal

81. I understand that, to ascertain the scope and meaning of the asserted claims, the court looks to the words of the claims themselves, the specification, the prosecution history, and, lastly, any relevant extrinsic evidence. *Phillips v. AWH Corp*., 415 F.3d 1303, 1315–17 (Fed. Cir. 2005)(*en banc*).

B. Means Plus Function

82. I understand that means plus function (“MPF”) claiming allows the claimed invention to be based on functionality, rather than the more traditional claiming technique that employs structure within the body of the claim itself. A claim term is functional when it recites a feature by what it does rather than by what it is.

83. I understand that 35 U.S.C. §112(f) expressly authorizes MPF claiming, and provides:

> (a) An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

35 U.S.C. §112(f).

84. I understand that a claim limitation is presumed to invoke 35 U.S.C. §112(f) when it explicitly uses the phrase "means for" or "step for" and includes functional language. I also understand that presumption is overcome when the limitation further includes the structure necessary to perform the recited function.

85. Furthermore, means treatment will not apply if POSAs reading the specification understand the term used to be the name for the structure that performs the function, "even if the term covers a broad class of structures and even if the term identifies structures by their function." Se*e, e.g., TecSec, Inc. v. International Business Machines Corp.*, 731 F.3d 1336, 1347 (Fed. Cir. 2013). In this regard, the term is not required to denote any specific structure or a precise physical structure in order to avoid MPF treatment. In *TecSec*, the Federal Circuit concluded that "system memory means" and "digital logic means" did not invoke MPF treatment, specifically explaining that "a system memory is a specific structure that stores data," and that digital logic means was specifically disclosed in the specification to be "comprised of structural elements, including a system memory and specific modules and subsystems."

86. By contrast, I understand a claim limitation that does not use the phrase "means for" or "step for" will trigger a rebuttable presumption that 35 U.S.C. §112(f) does not apply. I understand this presumption is not readily overcome, and, as such, the Federal Circuit rarely has found a claim limitation to trigger means plus function treatment without the recitation of

"means" language in the claim itself. *See*, *e.g.*, *Apple Inc. v. Motorola, Inc.*, 757 F.3d 1286 (Fed. Cir. 2014). I understand that this presumption may only be overcome if the claim fails to recite "sufficiently definite structure" or else merely recites a "function without reciting sufficient structure for performing that function." *Zeroclick, LLC v. Apple Inc*., 891 F.3d 1003, 1007 (Fed. Cir. 2018).

87. I understand the essential inquiry (when "means" is absent from a limitation) is whether the words of the claim are understood by POSA to have a sufficiently definite meaning as the name for structure. That determination must be made under the traditional claim construction principles, on an element-by-element basis, and in light of evidence intrinsic and extrinsic to the asserted patents. *Zeroclick*, 891 F.3d at 1007 .

88. I understand that a limitation has sufficient structure when it recites a claim term with a structural definition that is either provided in the specification or generally known in the art. *Apple Inc. v. Motorola, Inc.*, 757 F.3d at 1299. The limitation need not connote a single, specific structure; rather, it may describe a broad class of structures. *Id.* at 1300. It may also identify structures by their function (the mere fact that the disputed limitations incorporate functional language does not automatically convert the words into means for performing such functions, as many devices take their names from the functions they perform, *e.g.*, filter, brake, clamp, screwdriver, lock). *Zeroclick,* 891 F.3d at 1007; Apple, 757 F.3d at 1299. *See also, Skky, Inc. v. MindGeek, s.a.r.l.*, 859 F.3d 1014 (Fed. Cir. 2017)(to determine whether a claim recites sufficient structure, it is sufficient if the claim term is used in common parlance or by persons of skill in the pertinent art to designate structure, even if the term covers a broad class of structures and even if the term identifies the structures by their function)(*citing TecSec*, 731 F.3d at 1347).

89. I also understand that structure may also be provided, even if a patentee elects to use a "generic" claim term such as "a nonce word or a verbal construct," by describing the claim limitation's operation (*i.e.*, how the function is achieved in the context of the invention), such as its input, output, or connections. *Apple*, 757 F.3d at 1299-1300 .

90. I understand that the basic law relative to 35 U.S.C. §112(f) explains that a decision on whether a claim is indefinite under §112(f) requires a determination of whether those skilled in the art would understand what is claimed when the claim is read in light of the specification. If there is no structure in the specification, the POSA cannot save the disclosure by understanding what the drafter intended to be covered by the MPF limitation in the claims.

C. "Beam-Deflecting Element(s)"

'905 Patent: Claims 23–25, 27, 28, 31, 35, 46, 47, 49, 51–54
'906 Patent: Claims 133, 134, 139

91. The terms "beam deflecting elements" are well known and need no construction. The term itself sufficiently identifies the structure to a POSA. "Beam" refers to light beams. "Deflecting" refers to reflecting or otherwise changing the path of a light beam. Elements refers to constituent parts. "Beam deflecting elements" are mirrored or reflective parts of a beam deflector.

92. The claimed "Beam Deflecting Elements" (BDE) does not use the terms "means for" or "steps for." As such, I understand that the law presumes that these claim terms are not MPF elements. Separately, the claims do not recite a function for the BDE to perform. The claims specify that the BDE are (for example in claim 23 of the '905 patent) "positioned such that each element receives a corresponding one of said spectral channels;" but the specified language (and corresponding language in other claims) describes positioning of the BDE and not

the function of the BDE. I understand that each of these reasons provides an independent basis for concluding that MPF does not apply.

93. Additionally, a POSA would understand what is claimed when the claim is read in light of the specification. In preferred embodiments of the patents, multiple examples of beam deflecting elements known to a POSA are described: "The channel micromirrors may be provided by silicon micromachined mirrors, reflective ribbons (or membranes), or other types of beam-deflecting elements known in the art." '905 Patent 9:22-25.

94. Further, BDEs were not asserted to be subject to MPF in the inter parties reviews ("IPRs") for the '368 and '678 patents. I was an expert in those proceedings, and no party asserted that MPF applied.

95. As such, it is my opinion that one of ordinary skill in the art, reading the specifications and file histories, including the IPRs, would understand the "Beam Deflecting Element" structure, namely mirrored or reflective parts of a beam deflector array, and would not conclude that the BDE are MPF terms.

96. To the extent MPF applies, I understand that the claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof. The patents specifically describe micromirrors 103 in preferred embodiments. As such, the claims cover micromirrors and equivalents. Specific examples of micromirrors include silicon micromachined mirrors, reflective ribbons, and reflective membranes. ('905 patent, 9:22-25; '906 patent, 9:36-39).

97. An array of channel micromirrors 103 is depicted throughout the figures of the asserted patents, including figures 1A and 1B. Figure 1B is shown here.

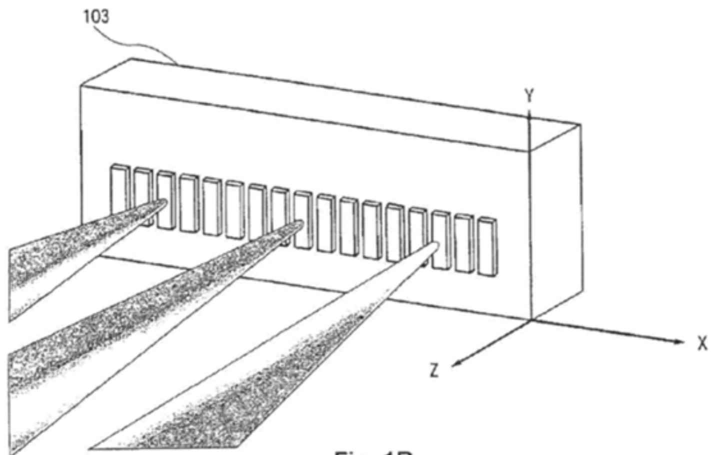


Fig. 1B

98. This disclosure is consistent with other pertinent patents directed to a POSA. For example, U.S. Patent No. 6,498,872B2 to Beouvitch, cited as prior art against the Asserted Patents, also discloses micromirrors: "Each sub-beam of light is transmitted to a lower portion of the spherical reflector 10, is reflected, and is transmitted to separate reflectors 51 and 52 of the MEMS array 50."

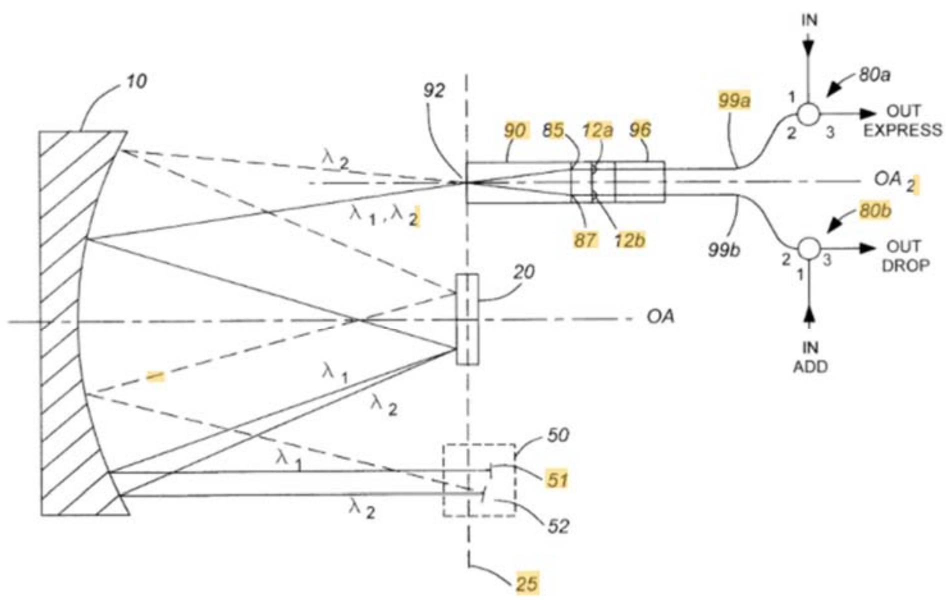


FIG. 11

99. The claims do not require that the BDE be "moveable." In the '905 and '906 patents, some claims specify that the BDE are "controllable" in two dimensions, but the claims

do not specificy that the BDE are "moveable." For example, claim 23 of the '905 patent specifies the BDE are "controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said output port or the fiber collimator ports and to control the power of the spectral channel reflected to said output port or the fiber collimator selected port." Similarly, claim 133 of the '906 patent specifies: "dynamically and continuously controlling said beam-deflecting elements in two dimensions to direct said spectral channels into any selected ones of output ports and to control the power of the spectral channels coupled into said selected output ports." One of ordinary skill in the art would understand controllable to mean capable of being controlled. A BDE element can be controlled, and deflected light direction altered, without the element being moved. Liquid crystals are controlled, for example, by changing the voltage applied to the crystal.

D. Continuously Controllable

'905 Patent: Claims 23, 47, 49, 51, 52
'906 Patent: Claims 68, 100, 115, 133

100. Various claims specify that the BDE are "continuously" controllable. "Continuously" is an adverb that modifies "controllable." A POSA would understand "continuously" controllable to refer to constant control as the plain and ordinary meaning suggests. Where "continuously controllable" is used, the claim requires the BDE to be *capable* of constant or continuous control. Where "controlling continuously" and "continuously controlling" are used in method claims of the patents, the methods require "actively controlling" the BDE.

101. As discussed above, continuous is used in the ordinary sense (according to Webster's Dictionary: "marked by uninterrupted extension in space, time, or sequence" – *see* https://www.merriam-webster.com/dictionary/continuous) to indicate uninterrupted control of

the elements to allow the channel micromirror in the preferred embodiment to scan its corresponding spectral channel across all possible output ports – a major improvement over two-state "digital" systems. The inventors aligned a plurality of ports, a diffraction grating, a lens, and a micromirror array in a configuration capable of directing an input light beam to multiple output ports. *See id.*, FIG. 1A. In a preferred embodiment, constant or continuous control of channel micromirrors allowed the position of the mirror to be continuously adjusted to direct corresponding channels to all possible output ports.

> As described above, a unique feature of the present invention is that the motion of each channel micromirror is individually and continuously controllable, such that its position, *e.g.*, pivoting angle, can be continuously adjusted. This enables each channel micromirror to scan its corresponding spectral channel across all possible output ports and thereby direct the spectral channel to any desired output port.

('905 patent, 8:38-45; '906 patent, 8:50-57).

102. Continuously does not mean "not stepwise." There is no "step-wise" definition or discussion in the patent, and there is no discussion of excluding "step-wise" rotation. The term "step-wise" does not appear at all. "Not stepwise" is at odds with the normal use of the term, which includes uninterrupted extension in "sequence."

103. Additionally, "stepwise" is within the invention, and not excluded, as one of ordinary skill in the art would recognize that the rotational angle can be set in many states or steps (as discussed above) to reflect the spectral channels into selected ones of the output ports.

104. The patents provide: "A distinct feature of the channel micromirrors in the present invention, in contrast to those used in the prior art, is that the motion, *e.g.*, pivoting (or rotation), of each channel micromirror is under analog control such that its pivoting angle can be continuously adjusted. This enables each channel micromirror to scan its corresponding spectral

channel across all possible output ports and thereby direct the spectral channel to any desired output port." ('905 patent, 4:19-26)('906 patent, 4:28-35).

E. Controllable

'905 Patent: Claims 23–25, 47, 49, 51, 52
'906 Patent: Claims 68, 89, 100, 115, 133

105. Controllable does not mean moveable. As stated above, the mirrors of the preferred embodiments are "individually controllable and movable." Controllable means capable of being controlled. Where motion is required, as in claims that specify rotation and/or pivoting, it is expressly stated. *See*, *e.g.*, claims 68, 76, 77, 95, 103, 111, 112, 115, 121, 127, and 128 of the '906 patent.

F. Controllable In Two Dimensions

'905 Patent: Claims 23, 47, 49, 51
'906 Patent: Claim 133

106. Various claims in the '905 patent specify BDE that are "controllable in two dimensions." Claim 133 of the '906 patent specifies a method that includes "controlling" BDE "in two dimensions." Again, controllable does not mean movable, let alone rotation about two axes. Where motion is required, as in claims that specify rotation and/or pivoting of micromirrors, it is expressly stated. Dimension is used in the ordinary sense to refer to a direction or quality. https://www.merriam-webster.com/dictionary/dimension

107. The claim language "controllable in two dimensions" and "controlling…in two dimensions" is not limited to a preferred embodiment where there is rotation of a mirror about an axis. Indeed, BDEs mentioned in the specification (*e.g.*, ribbons) do not rotate about two axes. ('905 patent, 9:22-25; '906 patent, 9:36-39).

108. A POSA would understand that the claims including BDE limitations were written to capture a broader invention where BDE are controllable in two dimensions. They are

not described as being moveable or rotatable as some BDE (e.g., ribbons) do not rotate. Other claims (primarily the independent claims of the ‘906 patent) were written to a narrower invention, where the claims specify “channel micromirrors being pivotal about two axes and being individually and continuously controllable.” In those claims, motion (pivoting) and controllability are specified. Thus, a POSA would understand that motion is not a component of controllability.

G. “A Control Unit for Controlling Each of Said Beam-Deflecting Elements”

’905 Patent: Claim 24

109. The term “control unit” is well known and needs no construction. The term itself sufficiently identifies a controller to a POSA.

110. The claimed “control unit” for controlling each BDE does not use the term “means for.” As such, I understand that the law presumes that this claim term is not MPF. In addition, the term “control unit” designates structure to skilled artisans – namely a controller. A controller is a foundational building block of optical systems and is well known to those of ordinary skill in the art. Moreover, the specifications show a controller coupled to the BDEs . See, e.g., FIGs. 4A & 4B.

111. Figure 4A is reproduced here with channel micromirror BDEs. In preferred embodiments, a POSA would clearly understand that a voltage control signal is sent from the processing unit of the servo control assembly 440 to channel micromirrors 430 as described in the patents.

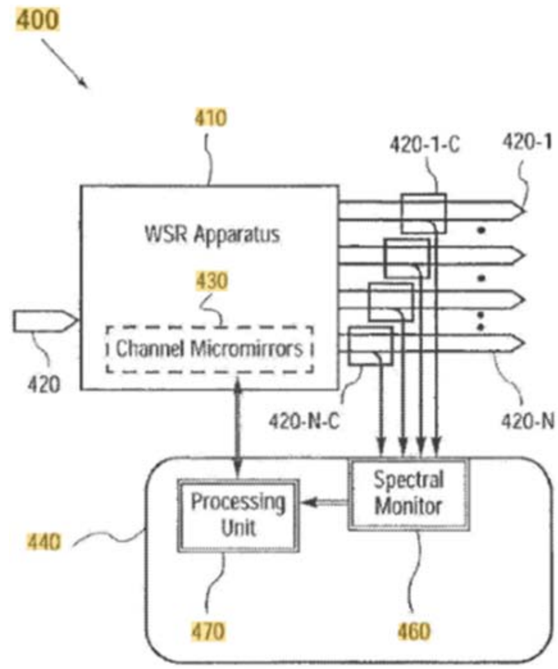


Fig. 4A

112. A controller is well known computing element in the art. In computing and especially in computer hardware, a controller is a chip (such as a microcontroller), an expansion card, or a stand-alone device that interfaces with a more peripheral device. This may be a link between two parts of a computer (for example a memory controller that manages access to memory for the computer) or a controller on an external device that manages the operation of (and connection with) that device. *See* Wikipedia at https://en.wikipedia.org/wiki/Controller_(computing). The peripheral device in the context of the invention is the array of beam deflecting elements.

113. Further, the “control unit” of claim 24 was not asserted to be subject to MPF in the prior IPRs. I was an expert in those proceedings, and no party asserted that MPF applied.

114. As such, it is my opinion that one of ordinary skill in the art, reading the ‘905 patent specification and file history, including the IPRs, would understand the “control unit”

structure, namely a controller, and would not conclude that the "control unit" of claim 24 was an MPF term.

115. To the extent MPF applies, I again understand that the claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof. The patent claims specify that the control unit includes a servo control assembly. The specification describes servo-control assemblies 440, 490 in preferred embodiments. ('905 patent, 11:25-12:61). The servo control assembly includes a processing unit 470, 495 in the preferred embodiments. As stated in the patents, "The processing unit 495 uses the power measurements from the spectral monitor 460 to provide dynamic control of the channel micromirrors 430…" ('905 patent, 12:6-8). As is well known in the art, and shown in the patent figures, the processing unit receives inputs, processes them, and provides outputs – in this case to drive the mirrors. The output drive from the processing unit is provided by a controller within the processing unit as described in claim 24. As such, if MPF applies, the claim covers controllers and equivalents.

116. In view of the above, it is also my opinion that one of ordinary skill in the art would not consider the claim to be indefinite.

117. First, one of ordinary skill in the art understands the term "control unit" to have a definite meaning as the name for a structure. As discussed above, a controller is well known computing element in the art. In computing and especially in computer hardware, a controller is a chip (such as a microcontroller), an expansion card, or a stand-alone device that interfaces with a more peripheral device. This may be a link between two parts of a computer (for example a memory controller that manages access to memory for the computer) or a controller on an external device that manages the operation of (and connection with) that device. *See* Wikipedia

at https://en.wikipedia.org/wiki/Controller_(computing). The peripheral device in the context of the invention is the array of beam deflecting elements.

118. Also, the claimed "control unit" is associated with control structure in the specification (which includes the drawings), and the structure of a controller well is known to those of ordinary skill in the art.

119. Also, the controller structure is identified by its functions. As discussed above, those of ordinary skill in the art were familiar with controllers.

H. "A Processing Unit Responsive to Said Power Levels for Controlling Said Beam-Deflecting Elements"/"A Processing Unit Responsive to Said Power Levels for Providing Control of Said Channel Micromirrors"

'905 Patent: Claim 25
'906 Patent: Claims 70, 90, 117

120. The term "processing unit" is well known and needs no construction. The term itself sufficiently identifies a processor to a POSA.

121. In addition, the term "processing unit" designates structure to skilled artisans – namely a processor. A processor is a foundational building block of optical systems and is well known to those of ordinary skill in the art. In computing, a processor or processing unit is a digital circuit which performs operations on some external data source, usually memory or some other data stream. *See* Wikipedia at https://en.wikipedia.org/wiki/Processor_(computing).

122. Moreover, the specifications show and the claims contemplate a controller that includes a servo 490 that includes a spectral monitor and a processing unit. ('905 patent, FIG. 4A, FIG. 4B, 11:25-12:61)('906 patent, FIG. 4A, FIG. 4B, 11:38-13:7).

123. Figure 4A is reproduced here again with channel micromirror BDEs. In preferred embodiments, a POSA would clearly understand that a control signal is sent from the processing unit of the servo control assembly 440 to channel micromirrors 430 as described in the patents.

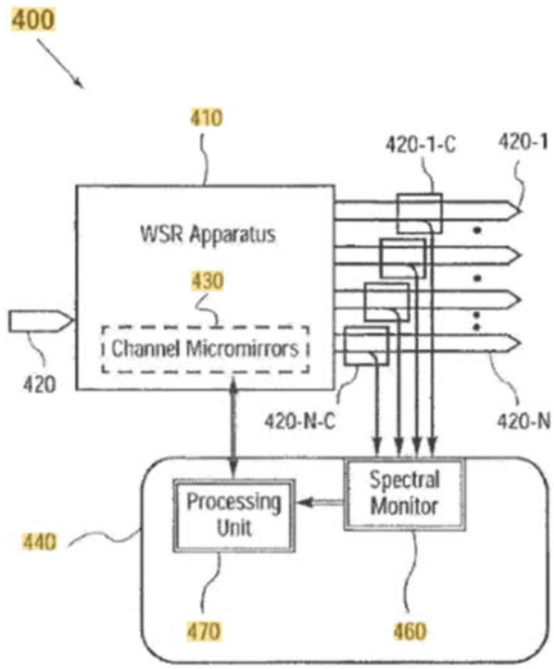


Fig. 4A

124. Further, the claimed "processing unit" was not asserted to be subject to MPF in the prior IPRs. I was an expert in those proceedings, and no party asserted that MPF applied.

125. As such, it is my opinion that one of ordinary skill in the art, reading the specifications and file histories, including the IPRs, would understand the "processing unit" structure, namely a processor, and would not conclude that the "processing unit" are MPF terms.

126. To the extent MPF applies, I again understand that the claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof. The patents specifically describe processing unit 470, 495 in preferred embodiments. ('905 patent, 11:25-12:61)('906 patent, 11:38-13:7). As such, the claim covers processing units (or processors) and equivalents.

127. In view of the above, it is also my opinion that one of ordinary skill in the art would not consider the claims to be indefinite.

128. First, one of ordinary skill in the art understands the term "processing unit" to have a definite meaning as the name for a structure. As stated above, a processor is a foundational building block of optical systems and is well known to those of ordinary skill in the art. In computing, a processor or processing unit is a digital circuit which performs operations on some external data source, usually memory or some other data stream. *See* Wikipedia at https://en.wikipedia.org/wiki/Processor_(computing).

129. Also, the claimed "processing unit" is associated with corresponding processing structure in the specification and the structure of a processor is known to those of ordinary skill in the art.

130. Also, the processor structure is identified by its functions. As discussed above, those of ordinary skill in the art were familiar with processors.

I. "A Power-Management System Configured to Manage Power Levels of at Least One of the First Spectral Channels and the Second Spectral Channels"

'905 Patent: Claim 44

131. The term "Power-Management System" is well known and needs no construction. The term itself sufficiently identifies a processor for controlling power to a POSA.

132. The claimed "power-management system" configured to manage power levels of spectral channels does not use the term "means for." As such, I again understand that the law presumes that this claim term is not MPF. In addition, the term "power-management system" designates structure to skilled artisans – namely a controller (manager) to manage power levels.

133. Moreover, the specifications shows a servo control assembly 490 that includes a spectral monitor and a processing unit for controlling power. In the preferred embodiment, the

servo 490 is configured to manage power levels of the spectral channels as claimed. ('905 patent, FIG. 4A, FIG. 4B, 11:25-12:61).

134. Further, the claimed "power-management system" was not asserted to be subject to MPF in the prior IPRs. I was an expert in those proceedings, and no party asserted that MPF applied.

135. As such, it is my opinion that one of ordinary skill in the art, reading the '905 patent specification and file history, including the IPRs, would understand the "power-management system" structure and would not conclude that the "power-management system" of claim 44 was an MPF term.

136. To the extent MPF applies, I again understand that the claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof. The specification describes a servo with processing units 470, 495 in the preferred embodiments. ('905 patent, 11:25-12:61). The processor is configured to manage power levels as claimed. As such, the claim covers processing units (processors) and equivalents.

137. In view of the above, it is also my opinion that one of ordinary skill in the art would not consider the claims to be indefinite.

138. First, one of ordinary skill in the art understands the term "power-management system" to have a definite meaning as the name for a structure – namely a controller (manager) to manage power levels

139. Also, the claimed "power-management system" is associated with corresponding structure in the specification and the structure of a power-management system is known to those of ordinary skill in the art.

140. Also the power-management system structure is identified by its functions. As discussed above, those of ordinary skill in the art were familiar with controllers.

J. "A Servo-Control Assembly…for Monitoring Power Levels of Selected Ones of Selected Channels"/"A Servo-Control Assembly… for Providing Control of Said Channel Micromirrors and Thereby Maintaining a Predetermined Coupling of Each Reflected Spectral Channel Into One of Said Fiber Collimator Output Ports"/"A Servo-Control Assembly…for Maintaining a Predetermined Coupling of Each Reflected Spectral Channel Into One of said Fiber Collimator Output Ports"/"A Servo-Control Assembly, in Communication with Said Channel Micromirrors and Said Output Ports, for Providing Control of Said Channel Micromirrors and Thereby Maintaining a Predetermined Coupling of Each Reflected Spectral Channel Into One of Said Output Ports"

'905 Patent: Claim 25
'906 Patent: Claims 69, 89, 116

141. The term "Servo-Control Assembly" is well known and needs no construction. The term itself sufficiently identifies a servo control to a POSA. A servo in the art uses feedback to control power.

142. The claimed "servo-control assembly," including for providing control of BDEs and for maintaining a predetermined coupling of channels into ports, does not use the term "means for." As such, I again understand that the law presumes that this claim language is not MPF. Separately, claim 25 does not recite a function for the "servo-control assembly" to perform. Claim 25 specifies that the "servo-control assembly" includes a "spectral monitor for monitoring power levels" of spectral channels. Thus, the alleged function ("monitoring power levels") is performed by the "spectral monitor," not the "servo-control assembly" (although the "servo-control assembly" includes the "spectral monitor"). I understand that each of these reasons provides an independent basis for concluding that MPF does not applly.

143. In addition, the term "servo-control assembly" designates structure to skilled artisans – namely a servo. A servo is a foundational building block of optical systems and is well known to those of ordinary skill in the art. Servos provide corrective control based on

feedback. Moreover, the specifications show and the claims contemplate a servo-control assembly that includes a spectral monitor and a processing unit. (‘905 patent, FIG. 4A, FIG. 4B, 11:25-12:61)(‘906 patent, FIG. 4A, FIG. 4B, 11:38-13:7). The Merriam-Webster Dictionary also defines assembly to mean a collection of parts that have been fitted together into a complete machine, structure, or unit of a machine. See https://www.merriam-webster.com/dictionary/assembly

144. Further, the claimed “servo-control assembly” was not asserted to be subject to MPF in the prior IPRs. I was an expert in those proceedings, and no party asserted that MPF applied.

145. As such, it is my opinion that one of ordinary skill in the art, reading the specifications and file histories, including the IPRs, would understand the “servo-control assembly” structure, namely a servo, and would not conclude that “servo-control assembly” are MPF terms.

146. To the extent MPF applies, I again understand that the claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof. The patents describe spectral monitor 460 and processing units 470, 495 in preferred embodiments. (‘905 patent, 11:25-12:61)(‘906 patent, 11:38-13:7). As such, the claim covers spectral monitors and processing units and equivalents.

147. In view of the above, it is also my opinion that one of ordinary skill in the art would not consider the claims to be indefinite.

148. First, one of ordinary skill in the art understands the term “servo control assembly” to have a definite meaning as the name for a structure – namely a servo control.

149. Also, the claimed "servo control assembly" is associated with corresponding structure in the specifications, and the structure of a servo is known to those of ordinary skill in the art.

K. Mirrors/Micromirrors/Micromachined Mirrors/Channel Micromirrors

'905 Patent: Claims 29, 35, 46
'906 Patent: Claims 68–70, 79, 82, 85, 89, 90, 96, 100, 115–117, 122, 123, 125, 126, 127, 129

150. Various claims recite "mirrors," "micromirrors," "micromachined mirrors," or "channel micromirrors." One of ordinary skill in the art, in light of the specifications and claims, would understand "mirrors" to be mirrored or reflective surfaces for reflecting light. One of ordinary skill in the art, in light of the specifications and claims, would also understand "micro" to mean small – so that "micromirrors" and "micromachined mirrors" would be understood to mean small mirrored or reflective surfaces for reflecting light.

151. Further, one of ordinary skill in the art would understand a "channel micromirror," in light of the specifications and claims, to be a small mirror that is "positioned to receive one of the spectral channels." ('905 patent, 4:9-11, '906 patent, 4:18-20).

L. Corresponding

'905 Patent: Claims 23, 47, 49, 51, 52, 54
'906 Patent: Claims 68, 89, 100, 115, 133

152. Various claims use the term "corresponding" in different contexts. For example, at least claims 23, 47, and 49 of the '905 patent require positioning of certain BDEs such that each receives a "corresponding one" of the channels. As another example, at least claim 51 of the '905 patent requires imaging of each of the channels onto "a corresponding" BDE. As a third example, at least claim 54 of the '905 patent requires controlling an alignment between the multi-wavelength optical signal and "corresponding" BDEs. As a fourth example, at least claims 68, 89, 100, 115 of the '906 patent require a beam-focuser, for focusing channels into

"corresponding" spectral spots. And, as a fifth example, at least claim 133 of the '906 patent requires focusing channels onto a spatial array of "corresponding" BDE, whereby each BDE receives "one of said…channels."

153. One of ordinary skill in the art, in light of the specifications and claims, would understand that "corresponding" is used in its normal sense; but is not limited to "one to one correspondence." Indeed, in the third example above (claim 54 of the '905 patent), there is clearly no "one-to one correspondence" between the multiwavelength optical signal and "corresponding" BDEs. Moreover, if "one to one correspondence" was required, certain other examples above would arguably contain superfluous language (*e.g.*, the fifth example, claim 133 of the '906 patent, which specifies that each BDE receives "one of said channels.")

154. This is also confirmed by the specifications, which also fail to limit "corresponding" to "one to one correspondence." *See*, *e.g.*, '905 patent, 7:42-45 and '906 patent, 7:54-57 ("For instance, the input beam and the corresponding diffracted beams generally have different cross-sectional shapes, so long as the angle of incidence upon the diffraction grating is not equal to the angle of diffraction…") '905 patent, 7:57-61 and '906 patent, 8:2-8 ("Moreover, the input multiwavelength optical signal is preferably collimated and circular in cross-section. The corresponding spectral channels diffracted from the diffraction grating 101 are generally elliptical in cross-section…"). The specifications also expressly use the phrase "one-to-one correspondence" when such a meaning is actually intended. *See*, *e.g.*, '905 patent, 10:2-9, 13:16-21; '906 patent, 10:16-23, 13:29-34.

M. Individually Controllable/Individually Pivotable

’905 Patent: Claims 23, 47, 49
’906 Patent: Claims 68, 89, 100, 115, 127

155. Various claims specify that the BDE are “individually” and continuously controllable, and claim 127 of the ‘906 patent specifies that the auxiliary channel micromirrors are “individually” pivotable. Like “continuously,” “individually” is an adverb that modifies “controllable.” Individually is used in a normal sense to mean that each element can be controlled.

156. Individually does not mean that a BDE must be controlled “separately from all other” BDEs. That is an additional limitation that is not set forth in the claims and is not compelled by “individually.” For example, while the BDEs are capable of being controlled separately from all other BDEs, that is not a requirement for the BDEs to reflect the channels into selected ones of the output ports.

N. Ports/Fiber Collimators … Providing Ports

157. The Asserted Patents generally discuss two classes of ports: input ports and output ports. Input ports include add ports and pass-through ports. *See, e.g.*, Appx287, 13:31-33 (“the pass-through port 630 and the add ports 660-1 through 660-M constitute the input ports”). Output ports include drop ports and also pass-through ports. *See, e.g.*, Appx283, 5:8-10 (“The output ports of the WSR-S apparatus include a pass-through port and one or more drop ports.”); Appx283, 5:20-22 (“The output ports of the first WSR-S (or WSR) apparatus include a pass-through port and one or more drop ports.”); Appx286, 12:46-48 (“a plurality of output ports, including a pass-through port 530 and one or more drop ports 540-1 through 540-N (N≥1)”). Citations here to the Asserted Patents (and ‘368 and ‘678 patents and applications) are from the Federal Circuit IPR appeal record.

158. In my opinion, one of ordinary skill at the time of the invention would have understood the term "port" in the original claims of the '368 and '678 patents to mean fiber collimator ports or fiber collimators serving as ports. The support for this construction is very heavy.

159. The Summary of the Invention expressly provides that fiber collimators *serve* as *both* the input ports and the output ports. According to the very first sentence in the Summary of the Invention, "[t]he present invention…employ[s] an array of fiber collimators *serving as* an input port and a plurality of output ports." Appx282, 3:54-57 (emphasis added). The appearance of this description in the very first sentence of the Summary of the Invention would lead one of ordinary skill in the art to believe that the invention as a whole was limited to input and output fiber collimator ports or fiber collimators serving as ports and that the ports must be fiber collimator ports or fiber collimators serving as ports.

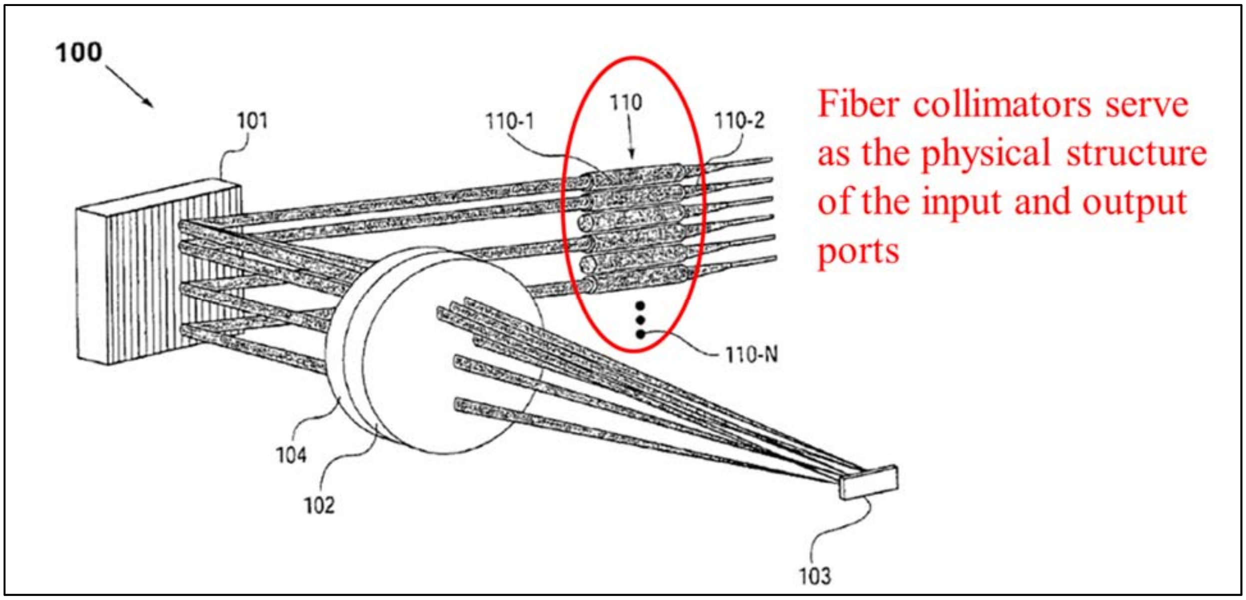
160. Additionally, the fiber collimator structure provided for "port" in the Summary of the Invention is consistent with the characterization of port in the specification as a whole. In my opinion, one of ordinary skill in the art would understand that the patentee was not merely providing examples of the invention, but rather that the patentee intended for the ports to have a fiber collimator physical structure as stated in the first sentence of the summary of the invention.

161. The specification as a whole is without ambiguity on this issue: fiber collimators serve as the physical structure of the claimed ports. The specification repeatedly makes this relationship clear. *See, e.g.*, Appx282, 4:26-27 ("The fiber collimators serving as the input and output ports"); Appx284, 8:35-36 ("the fiber collimator grating serving as the output port"); Appx285, 9:20-21 ("The fiber collimators serving as the input and output ports"); Appx285, 9:62-63 ("the fiber collimators (serving as the input and output ports)"); Appx285, 10:29-32 (In

FIG. 3, "the one-dimensional fiber collimator array 110 of FIG. 2B is replaced by a two-dimensional array 350 of fiber collimators, providing for an input-port and a plurality of output ports."); Appx285, 10:52-53 ("the fiber collimators that provide for the input and output ports"); *see also* Appx281, 2:44 ("port/fiber"); Appx284, 8:33-34 (output ports have a "fiber core"). In my opinion, one of ordinary skill in the art would be left with no doubt about the meaning of the claimed ports.

162. Similarly, this physical characterization of "port" as a "fiber collimator" is also set forth in the description of the figures. The specification explains that Figure 1A, which is also printed on the face of the patents, depicts an apparatus that includes "an array of fiber collimators 110, providing an input port 110-1 and a plurality of output ports 110-2 through 110-N (N≥3)." Appx283, 6:58-60. In discussing 110-1 through 110-N, the specification uses the term "port" and its physical "fiber collimator" structure interchangeably. *See, e.g.*, Appx283, 6:65 ("input port 110-1"); Appx284, 7:9-10 ("output ports 110-2 through 110-N"); Appx284, 8:19-20 ("output ports 110-2 through 110-N"); Appx285, 10:14 ("fiber collimators 110-1 through 110-N"); Appx285, 10:21 ("fiber collimators 110-1 through 110-N").[1] Thus, both the description of the figure and the description of the figure's components (110, 110-1 through 110-N) delineate the physical structure of "port" as a fiber collimator. An annotated version of Figure 1A is reproduced below.

[1] Figures 2A and 2B also use the 110 and 110-1 through 110-N nomenclature. *See* Appx273-274.



163. The physical delineation of ports as fiber collimators was also recited in the original claims of the '678 patent before the recent reissue. For example, independent claims 1 and 21 of the '678 patent recite that the physical structure of the claimed ports is multiple fiber collimators: "multiple fiber collimators, providing an input port for a multi-wavelength optical signal and a plurality of output ports." Appx287, 14:8-10 (claim 1); Appx288, 15:31-33 (claim 21). Likewise, independent claims 31, 37, and 44 of the '678 patent recite that the physical structure of the claimed ports is an array of fiber collimators: "an array of fiber collimators, providing an input port for a multi-wavelength optical signal and a plurality of output ports." Appx288, 16:18-20 (claim 31); Appx288, 16:57-59 (claim 37); *see also* Appx289, 17:34-37 (claim 44)("an array of fiber collimators, providing an input port for a multi-wavelength optical signal and a plurality of output ports including a pass-through port and one or more drop ports"). And claim 55 recites that the physical structure of the claimed ports is multiple auxiliary fiber collimators: "multiple auxiliary fiber collimators, providing a plurality of auxiliary input ports and an exiting port." Appx289, 18:29-30 (claim 55).

164. The specification also distinguishes between ports and circulators. In my opinion this would also lead one of ordinary skill in the art to believe the claimed ports must be fiber collimator ports because the fiber collimator structure rules out circulators. Conversely, if one were to view the term "port" as broadly as possible, without the fiber collimator structure, the term "port" could include circulator ports.

165. The patent specification consistently distinguishes ports from circulators. It never uses the two terms interchangeably or suggests that one is subsumed within the other. The patents' only mention of circulators is in the background section's discussion of the state of the art and the *problems* with the art's use of circulators. Circulators are not mentioned a single time when the actual invention is being discussed: there is not one mention of circulators in the Summary of the Invention, the Detailed Description of the Invention, or the claims. And nowhere do the patents indicate that circulators are the same as, or can be subsumed within ports.

166. Importantly, when circulators are discussed in the background section, the patents discourage their use. In discussing the prior art, the patent discourages the use of circulators, explaining that "the optical circulators implemented in [a prior art system] for various routing purposes introduce additional optical losses, which can accumulate to a substantial amount." Appx281, 2:54-57.

167. Also, even when discussing circulators in the prior art, the '368 and '678 patents describe the circulators as being coupled to, rather than part of, ports. For example, in discussing a prior art system, the patent explains that "[a]n optical circulator is therefore *coupled to* the input port." Appx281, 2:31-32 (emphasis added); *see also, id.* at 2:34-35 ("An additional optical circulator is thereby *coupled to* the output port")(emphasis added); Appx281-282, 2:67-3:9

(discussing a piece of prior art that has "input, output, drop and add ports" and no "additional optical components (such as optical circulators…)").

168. Because the circulator in the prior art system is described as separate from the port or "coupled to" the port, it is clear the circulator is not the same as or encompassed by the port.

169. In my opinion, in view of the specification's consistent differentiation between ports and circulators, one of skill in the art reading the specification would not equate circulator with port.

170. One of ordinary skill in the art would also understand that Capella clearly and unmistakably defined the term "port" in the IPRs for the '678 and '368 patents to mean fiber collimator ports or fiber collimators serving as ports. During the IPRs, I submitted declarations asserting this point, incorporated here by reference, and Capella submitted briefing in which it defined ports as stated and distinguished and disavowed circulators from the definition of ports.

171. For example, in the Patent Owner Response for the IPR of the '368 patent initiated by Cisco (IPR 2014-01166), in order to overcome prior art, Capella defined the claims as being limited to fiber collimators serving as ports, and excluded circulator ports from the definition. Among other things, Capella argued:

> The '368 Patent explicitly labels the ports "collimators" and says throughout the specification that collimators serve as the ports. The ports in the '368 Patent are **not** circulator ports. Construing the claimed ports to read on optical circulator ports is contrary to the '368 Patent and undermines the capabilities of the '368 Patent brought to the industry."

(Paper No. 19, Case IPR2014-01166 of U.S. Patent No. RE42,368, p. 7).

…

> In addition to the combination of embodiments of Bouevitch and the combination of Bouevitch and Smith being non-obvious, the Board should uphold patentability *because* Bouevitch's circulators cannot meet **the claimed ports, *i.e.*, collimators".**

(Paper No. 19, Case IPR2014-01166 of U.S. Patent No. RE42,368, pp. 31-32)(emphasis added).

172. The ‘’217 Provisional also delineates the physical structure of ports as fiber collimators and distinguishes ports from circulators. In describing the prior art, the figures, and the invention, the ’678 Provisional consistently expresses the physical structure of ports as fiber collimators. In describing a known piece of prior art, the provisional states that it “has four fiber ports: (1) input, (2) pass-through, (3) add, and (4) drop.” Appx4932. This terminology is also seen in the figure describing the prior art, which explains that it is a “4-fiber device: Input, Pass-Through, Add, & Drop.” Appx4941.

173. In describing the invention, the provisional states that “[t]he input/output consists of a linear array of fiber collimators.” Appx4933. It goes on to further explain that “[t]he top collimator is designated the input, the second collimator is designated the pass-through, and the remaining collimators are designated as drop ports.” *Id.* Tellingly, the phrase “output collimator ports” is repeated four times when describing the invention. Appx4934-4935.

I declare under penalty of perjury of the laws of the United States that the foregoing is true and correct.

Executed on November 6, 2020 at Boston, Massachusetts.

/s/ Alex. Sergienko

Alexander Sergienko

CERTIFICATE OF SERVICE

The undersigned hereby certifies that the foregoing document, entitled Declaration of Alexander Sergienko, was served on all counsel of record who have consented to electronic service on this 6th day of November, 2020.

/s/ Robert D. Becker
Robert D. Becker